AMERICAN MACHINIST

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Improved Screw Machine.

The first engraving on this page is of a 19″ screw machine, which represents a line of similar machines from 15″ to 22″, as built by Bardons & Oliver, Cleveland, O.

The machine has an especially well-supported main bearing for the spindle, the box being supported its entire length by the upright. The box is made of phosphor bronze, in halves, and in such a way that its renewal is an easy job for any good lathe hand. The end thrust of the spindle is taken at the front end of this box, and lost motion at the rear end of the same box. Spindle has 2½″ hole through it.

A new design of geared friction clutch is applied to the head, which is worked in the usual way by the vertical lever shown, and is fully protected, its especial point being its non-liability to injurious wear, and the fact that all adjustments called for by what wear does take place are made by ring nuts outside, so that they are easily accessible, and readily manipulated.

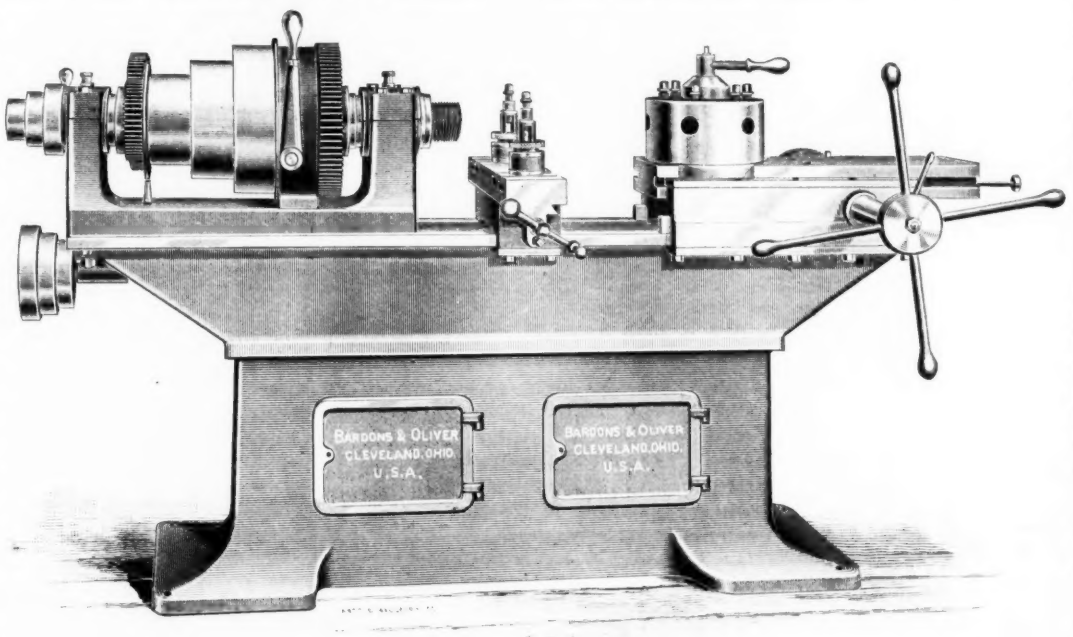
The turret slide has an automatic feed of 11″, and an automatic release. Turret revolves automatically, and can be firmly clamped during a cut, if desired. It has six 1¼″ holes. Turret revolves upon hardened and ground bearings, and has a hardened tool steel index ring.

The alignment of the turret holes with the spindle is easily maintained by means of taper wedges or gibs, which extend the entire length of the turret block, and provide for both lateral and vertical adjustment.

The cut off slide is operated by either a screw, or a rack and pinion, and it can be provided with a hand or automatic feed along the bed, if desired.

An automatic chuck and wire feed can also be applied to the machines, by which the rod is released, fed forward, and gripped without stopping the machine.

The length of bed is 78″; greatest distance from end of spindle to face of turret, 26″; largest diameter of cone, 13½″; width of belt, 3½″; shipping weight, about 3,000 pounds.

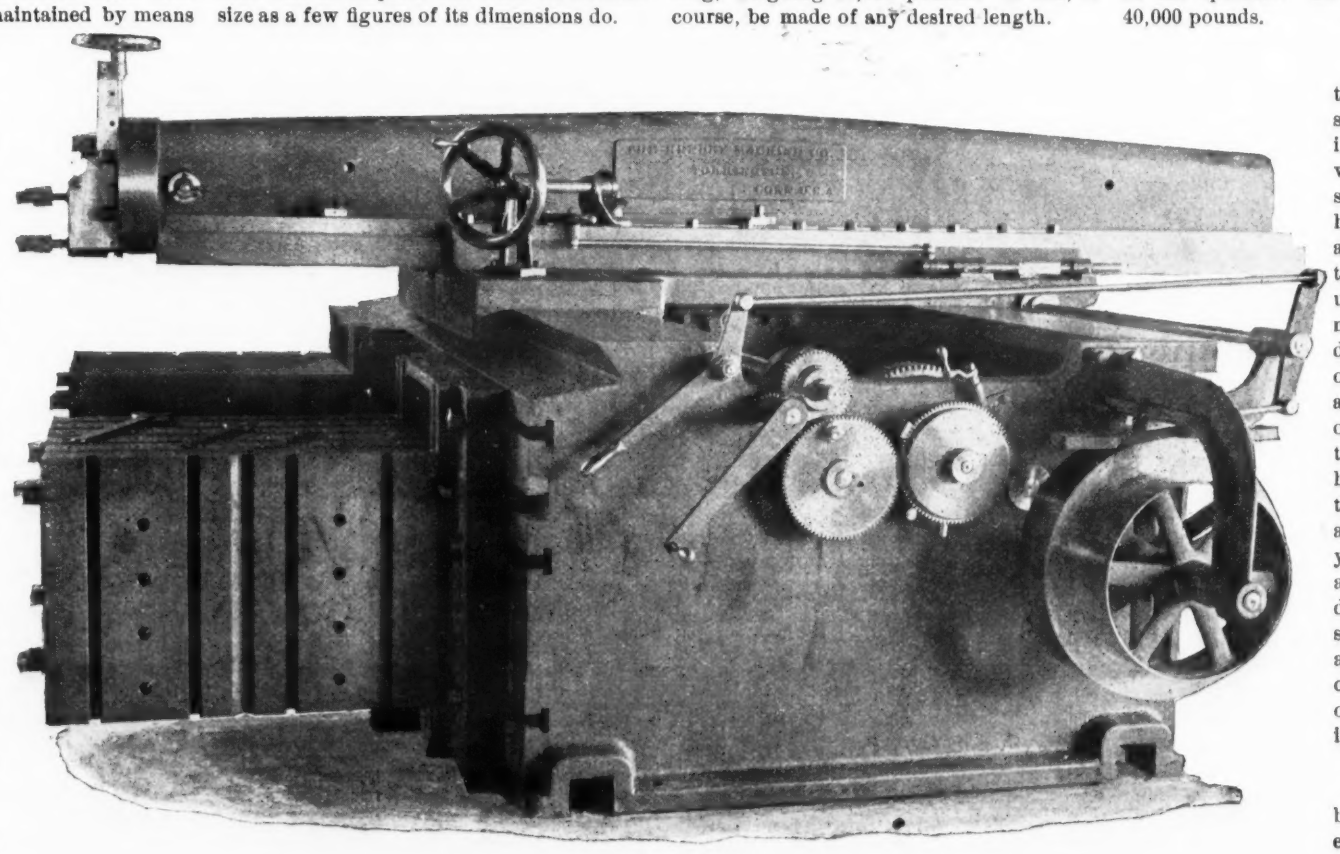


IMPROVED SCREW MACHINE.

We are now enabled to present an engraving of the machine which gives an accurate idea of its appearance, though it perhaps does not so impress one with its unusual size as a few figures of its dimensions do.

A Six-foot Shaper.

We have previously referred in these columns to an uncommonly large and heavy shaper built by the Hendey Machine Co., of Torrington, Conn., for planing parts of heavy punching and shearing machines.



A SIX-FOOT SHAPER.

The stroke of this shaper is six feet, and the movement of the saddle upon the bed is the same. The ram, exclusive of the head, is 12 feet 8 inches long, is 3½ inches thick under the caps which hold it to the saddle, is 20 inches wide at bottom, and has a bearing in the saddle 60½ inches long. The rib on top of the ram is 20 inches deep, 7 inches thick, and the ram weighs 3,814 pounds, or nearly two tons.

The saddle has a bearing on the bed 60 inches long, and from front to rear its bearing on bed is 61½ inches. The saddle weighs 4,565 pounds. The bed is 67½ inches wide over all, stands 42 inches high, and is 11 feet long, weighing 16,750 pounds. It can, of course, be made of any desired length.

The two aprons on the front of the machine are 36 inches by 36 inches, and each carries a table 36 inches long, 30 inches wide, and 24 inches deep. With the aprons these weigh nearly 5,000 pounds each.

The driving pulleys are 24 inches diameter and carry 2½ inch belts, the driving belt having a speed of 96 feet to 1 of the ram. Belts are shifted one after the other, the same as in a planer, and can be shifted either to reverse the ram or stop it at any point by means of the lever shown at end of bed and connected to shifting mechanism.

Motion is given the ram through the medium of a cut rack and pinion of 5 inches face. The saddle can be moved from the right hand end of the machine by hand, and on the other end of the machine is a set of pulleys to move it in either direction by power. The machine is provided with power feed in all directions, and is arranged to work from either end of the bed. The hand wheel on the saddle is to move the saddle by hand when setting tools to the work. The head has automatic down feed controlled by the small lever shown just back of the head on the cutter bar.

The weight of the tables in front rests upon ball thrust bearings and the thrust of the screw for moving saddle is taken in the same way.

All important bearings on the machine are bushed with hard phosphor bronze, and all shafts and screws are of steel.

Notwithstanding its great weight and size the machine is so arranged as to be convenient to handle, and is under easy control of the operator. Its entire weight is over 40,000 pounds.

We have received from the Massachusetts Institute of Technology, Boston, Mass., a pamphlet giving times and places of entrance examinations which are held in the various principal cities of the country. Pamphlet is sent to those interested upon application.

We have all known the mechanic who spent most of his time in explaining why his work was not just as it seemed desirable to have it, and the manager of industrial establishments whose utter failure to really manage anything was due to the perversity of employes, the ignorance of his employers, or everything and anything, in fact, except his own unfitness for the place. Such men are typified by the young man who stated as his reason for not dancing that: "I should like to dance, and I should dance, only the music puts me out and the girl gets in my way."

The recent denial by presidents of Eastern Trunk Lines of an intention to reduce wages, as it had been rumored their intention was to do, is said to have had a favorable effect upon Wall street dealings, but we have no doubt its favorable effect upon business generally was far more important.

Hardening and Smithing Processes.

BY B. F. SPALDING.

Hardening small circular saws of an ordinary size, such as are used for slotting screws and work of that character, is not difficult, if advantage is taken of the well-known fact that when the saw plate is less than an eighth of an inch thick it will harden when pressed between two cold level plates. Indeed, saws much larger and thicker than these have been hardened in this manner. The pressure, as Mr. Goodyear stated some years ago in the AMERICAN MACHINIST, has no other effect than simply to bring the surfaces into contact close enough to insure good conductivity, in order that the heat may be rapidly abstracted from the object which is to be hardened, as quick cooling is the essential point in hardening.

The conditions for hardening these small saws are: (1) steel of good hardening quality; (2) a good heat; (3) getting the pressure plates to bear quickly and evenly; (4) the surface of the pressure plates should be well oiled with some thick oil; (5) the plates should be massive enough to absorb the heat without becoming much heated themselves.

Where only a few of such articles are wanted occasionally, it will hardly pay to make a special apparatus to harden them with, as most any two blocks with plane surfaces—the face of the anvil, and an old die, for instance—will fairly answer the purpose. Both the faces should be well oiled; the saw, after being heated, is quickly laid upon one, and a helper, having the other in his hands, brings it down upon the saw at once, and works it about a little to insure a level bearing.

The design shown in Fig. 1 is for use in places where there is enough of this kind of work to pay the storage of a machine kept for this especial purpose. Such little things can often be made at odd times, when they really cost nothing but a little looking after by the foreman.

The features of this machine are its compactness, and its being level-headed at all times, as well as being a dead head, which will not rebound when it is brought down hard, and suddenly, upon the saw. The dimensions of the parts may be modified to suit circumstances. This one is a purposely loose-jointed affair; the lower block, as shown, is 2″x4″x13″; the links, 1″x½″x5″ between centers; the upper block is 1″x4″x5″; the distance between centers in the block, 4″. That handle on top must set on the upper block loose enough to take the rebound; any kind of a loose weight will do the duty as well.

The cut represents a recess of slight depth turned out in the lower block to receive the hot saws when they are delivered; something of the kind is needed, for they slip about with great facility; three low pins at the circumference would be an equivalent, or a spring pin, rising up in the center, would do if the saws were handled with tongs.

Very good success will attend a careful man who heats and hardens a number of saws together on a rod. The rod designed for this purpose, which is shown in Fig. 2, is a variation from the bolt and washers which are sometimes used. By putting a bolt through a lot of saws, and squeezing them up firmly between a washer under the head, and one under the nut, which are as large as the saw is at the bottom of the teeth, the teeth of that bunch of saws may, by skillful maneuvering, be brought to a hardening heat without getting the bodies of the saws hot enough to harden. It is a good plan to use a little cyanide on them, and dip them in oil. The teeth will be hard, and the centers soft. By shrinking in cooling they get looser than any one would expect, and are liable to warp.

Fig. 2 represents an inexpensive device for keeping sufficient pressure upon the sides of the saws while they are cooling, to keep them straight. This prevents the first slight inclination for them to crook by keeping them so closely together that the oil has no ingress between them. It is simply a half-inch bolt, passed through a washer half an inch thick; then through a string of saws; then through a piece of gas pipe with a collar on each end; then through a flat spiral spring, a washer and nut The nut is screwed up enough to bring whatever pressure is needed upon the saws by the tension of the spring. The bolt may be about 24″ in length. Seven inches of 1″x⅛″ steel, with the ends cut at opposite angles of 45 degrees, will make

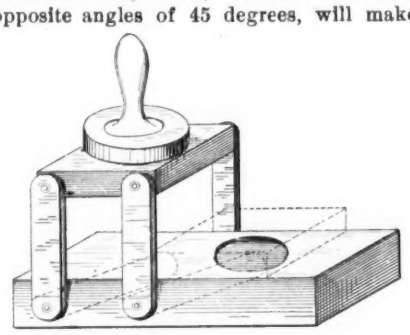


Fig. 1

the spring by winding it around a $\frac{9}{16}$″ rod. The spring is far enough from the fire, so that its efficiency will not be lessened by having the temper drawn by the heat.

In blacksmithing which, in its original sense, is smiting unbrightened iron, the smiting, or striking a blow, is such an important element of the work, that everything that relates to the nature, characteristics, qualities, tendencies, capabilities, varieties, and effects of blows, is a subject of interest to the blacksmith at all times. Their study is constantly presented to him, from the time he first picks up his hammer in the flush of youth, till it drops from his nerveless grasp in the feebleness of age. I know it was about the first thing that presented itself to my mind in my earliest effort to hammer anything on an anvil. I was just entered as an apprentice, and had got hold of an old flint-lock horse pistol. This weapon, of indifferent precision, lacked the cap which screws down upon the flint to fasten it into the hammer, and I concluded to make one out of a bit of scrap iron which I found, that I judged would be just the right size when I had hammered down the bevel on the upper side. Could have filed it, but was not I going to be a blacksmith? or what was I here for? Easy enough thing to hammer it; so I heated it, not very

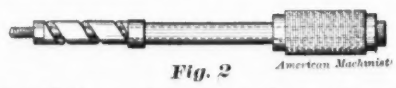


Fig. 2

hot, laid it on the anvil, and struck it a "skew" blow to bevel it. Gee, whizz! That was the last I ever saw of it.

> Swifter than eagle's wing it clipped through the air,
> And lodged in some interstice, I never knew where.

Never found it! "Dangerous thing!" I thought. "Lucky it didn't hit me!"

The same kind of a skew blow is used in making side tools for lathes. Fig. 4 shows the position of a hammer on the steel in smithing a side tool. The tool will not be driven away by a blow at this angle, if it is made soft enough by heat and the blow is struck in the right manner.

Let it be remembered that the blow does not need to be struck in a straight line with the axis of the hammer, as in the line *A*, but although the hammer is in the position shown in the cut, the blow can be struck in the direction of the line *B*. This can be done just as well as a blow can be struck either with the edge or with the flat of a saber. It is evident that the blow struck in the direction of the line *B* will be as usefully effective as one struck along the line *A*, while at the same time it will have much less tendency to drive the steel off from the anvil. I have never met with an anvil so smooth that the tool would not hug to it, provided the anvil was clean and exposed its bare surface to contact with the steel. Oil, varnish, soda or soapy water will make it slip; clean water or salt water will not.

It may appear odd that varnish should be mentioned as one of the things which will make a tool slip on the anvil, as it is a thing which doesn't seem likely to get there to make trouble, but I got caught once with it, and any one else is liable to who gets a new anvil, as I did when I first went to work for the American Machine Works, in Boston. General Manager Radford wanted me to get an anvil to suit myself, and I got a new one, with a narrow face, expressly for tool-dressing. The first tool I tried on the new anvil was a side tool, and when I struck it obliquely it flew like a bird. If I hadn't had a good hold on its tail I should have lost that also. I could not make it stick until I had cleaned off the varnish which had been painted on it (by Mr. Peter Wright or Mr. Eagle, I presume) to preserve it from rusting.

It used to be thought quite a trick to hammer out a five sided reamer on the anvil. Referring again to the illustration, Fig. 4, a five-sided figure—pentagon—may be seen upon the anvil face, and the dotted line shows about the angle at which a side tool is hammered. It will be observed that to hammer out a five-sided reamer, the steel must be struck with the face of the hammer more oblique than in making a side tool but there is no great difficulty in keeping the steel in place without the manifestation of any tendency to move sidewise, provided

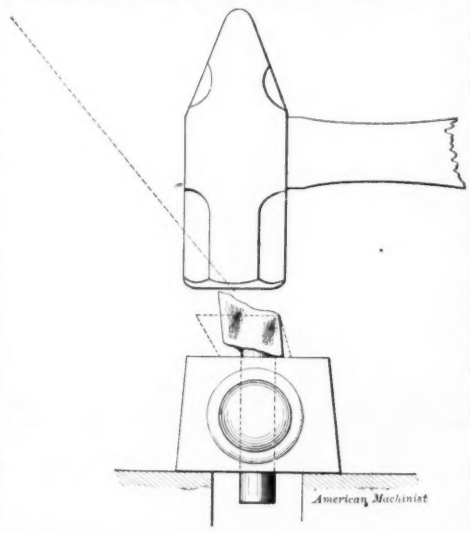


Fig. 3

the direction of the blow is in a right line perpendicular to the anvil face irrespective of the obliquity of the hammer face.

The softer the metal is made by heat the better it sticks to the anvil, and the less tendency there will be for it to move about under a skewing blow. I have a circumstance in my mind which demonstrates that it is not such a very difficult matter to hammer a piece five sided; and if it were not an utterly incredible story I would tell it—I'll tell it anyway, if it is incredible, for I know it is true.

In 1857, times were awful hard in New England. Able-bodied men, good mechanics, were running about all over the country offering to work for their board—a very unwise and even wicked thing to do. One came to the shop where my father was foreman, and as they needed another blacksmith he was hired at the regular rate of wages. His first job was on an order for six-sided—hexagon—nuts, three inches across the flats, 1½″ thick, hole 1½″. No tool to shape them in—had to be hammered out into shape on the anvil, and by night he had something like a peck of them, all well made, *but all five sided*. He said he "thought they looked queer, but didn't know why!" Did they discharge him? No, sir! What, discharge a man who could

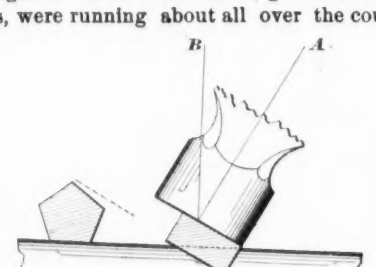


Fig. 4

make five sided nuts all day and not know it? I guess not! They simply expostulated with him, represented how inconvenient it was to get a wrench on those odd nuts and begged for one more side to them, to make them even. These measures prevailed, and when he got over his hunger tremor, got his nerves steadied and his stomach pains soothed by a bread-and-butter anodyne, he put the sixth side on the nuts and eventually did the shop much good work.

Having shown that five sided pieces can be hammered upon the anvil, it is evident that there is no regular shape, except it may be three-sided pieces, which cannot be hammered. All pieces of an even number of sides, quadragons, hexagons, octagons, decagons, and so on, are easily made, because in them every side has an opposite side, and when one side lies upon the anvil its opposite side lies parallel, and can be struck flat with the hammer. But in all pieces of an odd number of sides there is an angle opposite to every side, so that when any side lies flat upon the anvil the hammer blow must be always with the face oblique, but always less oblique in the heptagon, nonagon, and those of a greater number of sides than in the pentagon; therefore, if the pentagon can be hammered, any regular shape with a larger number of sides can be hammered on the anvil with no other tools but the hammer—every regular shape except the triangular, and I never heard of any one who could hammer out a regular "three-square" on the anvil without any other tools.

In striking with a hand hammer, there is a tendency to draw the blow towards the body. This is owing to the natural play of the muscles of the arm and shoulder. This fact is so well known among blacksmiths that the old process of making bolts in a hand-heading tool makes constant use of this principle. When the stock is upset or driven together for a head, it is quite apt to get anywhere else except central with the body of the bolt.

Fig. 3 represents a bolt in a heading tool; it has been in the tool before, and the head was driven down until it assumed the shape shown by the dotted lines. It was then taken out from the heading tool and hammered until the sides of the head stood straight with the body. It is shown now as put back into the tool in such a position that the drawing blow of the hammer—indicated by the dotted line rising to the left—will draw the head over and distribute the stock centrally around the body. The stock moves in the direction of the lines of force, which are not dependent upon the arrangement of matter about the axial line of the hammer, but upon the course and direction of the motion. The line of force in moving bodies is coincident with the line of motion.

One word of words: We write about "three-sided" pieces and "five-sided" pieces, but in the shop, where we speak our own language, which we have a perfect right to do, we understand each other perfectly when we speak of "three square" and "five square," or any number of squares, meaning equal sides—not sides alone, but equal sides. It appears to me that we come nearer to expressing our exact meaning when we say "three-square" than when we say three-sided. "Three-sided" might have unequal sides, but "three-square" stands unequivocally for three equal sides. We do not allow the quadrangle to usurp the title of "square," but give the other figures an equal chance.

Teacher—Give a synonym for the word "reduce."

Bright Boy—Equalize.

"Wrong."

"Well, that's the word the railroads use when they reduce wages."

"Hum! Give a synonym for the word 'increase.'"

"Equalize."

"Nonsense."

"Well, that's the word the railroads use when they increase rates."—*Good News.*

Screw Machine.

We illustrate herewith an improved screw machine, intended specially for the heavier classes of work in the line of studs, bolts, etc. For this purpose it is given unusual driving power, and is provided with a friction clutch in the head by which the change is made to or from back gears without sacrifice of driving power.

Spindle is of large diameter, and has a $2\frac{1}{8}$" hole through it. It runs in phosphor-bronze boxes which have means of taking up wear.

A new chuck is supplied with the machine, which takes stock from $\frac{1}{2}$" to $2\frac{1}{16}$" diameter without change of jaws, and obviating the use of collets or thimbles.

The turret is hexagonal, permitting of heavy box tools with broad bases to be clamped against its flat faces, and also avoiding the use of hollow stems when working upon long pieces. The turret and turret stem are so bored that pieces of $1\frac{1}{8}$" diameter will pass entirely through.

The turret slide has power feed in addition to the pilot wheel, and is provided with an automatic stop.

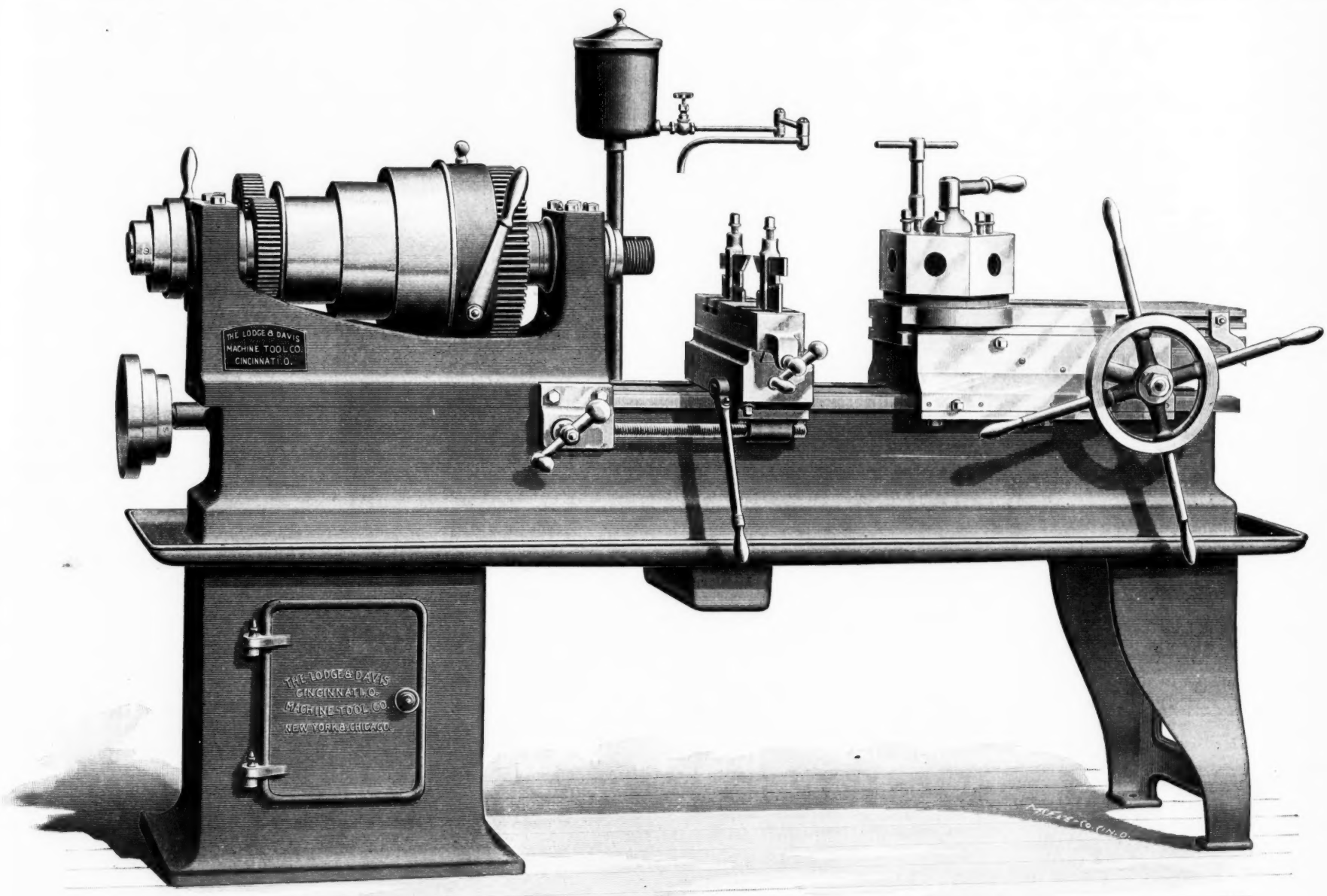
The alignment of the turret slide is maintained by taper gibs. The turret saddle also has a taper gib at its base, by means of which the tools in the turret can be kept in line with the center of spindle.

The friction device in the head, already referred to, is so designed as to be easy to operate, and all adjustments for wear can be made from the outside. The cutting-off rest has longitudinal and cross motion, and the latter may be changed from lever to screw feed by simply tightening a set screw.

The column under the head is fitted up as a cupboard for the reception of tools, fixtures, etc.

Each machine is furnished with automatic pump, oil pan, double-friction countershaft, wrenches, etc.

The builders are the Lodge & Davis Machine Tool Co., Cincinnati, O.



SCREW MACHINE.

About Emery Wheels.

BY O. S. WALKER.

An emery wheel may be compared to a milling cutter with an infinite number of teeth, the chips or material removed being infinitesimally small as compared with the cuttings of ordinary tools. The action of the emery wheel, however, differs from that of the milling cutter, inasmuch as the emery wheel is self-sharpening, and is valuable only when it combines this feature with the necessary durability. It is evident that an emery wheel to work well, must be undergoing a steady diminution of diameter while in use, and a wheel that holds its size and shape best is the slowest cutter, but it does not follow that the fastest cutting wheel wears away the fastest. A coarse wheel cuts faster than a fine wheel, for the same reason that a coarse file will cut faster than a fine one, and because the texture of the wheel is more open, thus preventing clogging or glazing. There are certain underlying principles involved in emery grinding, which, if properly understood, assist greatly in obtaining best results.

A principle that is often lost sight of is the fact that, theoretically, the diameter of the wheel should be proportionate to the amount of material to be removed.

Whenever possible, the diameter of the wheel should be four times the diameter of the work (for example, in cylindrical grinding), and it should hardly be expected to keep its original diameter after having ground an area of surface represented by two or three times its own circumference. It is evident that the tendency of any emery wheel is to grind a surface tapering or wedge shaped. It is also evident that such a surface might be a *true surface*, *i. e.*, provided wear is even.

It is a common fallacy to expect that a small wheel can be *speeded up* to do the work of a larger wheel; not only is the cutting material insufficient, but the wear-ing away of a certain amount of substance of the wheel will change the diameter of the smaller wheel much faster than the larger one, and a poor result is obtained.

To sum up, the emery wheel should possess an advantage (of large diameter) over the more solid nature of the work operated upon, to obtain best results economically.

To correct the tendency of an emery wheel to glaze, a variation in speed is often taken advantage of, as slowing down the wheel beyond a certain point decreases its cutting properties, and the work gaining an added advantage, helps to crumble away the wheel, thus maintaining a keen cutting surface.

The proper width for an emery wheel is determined, in a great measure, by the conditions under which it is employed. As a general rule, the width of a wheel should be no greater than is consistent with the proper strength of the wheel as a whole. A wheel 10 inches diameter and $\frac{1}{2}$ inch thick is a good proportion for a wheel to use in cylindrical or plain surface grinding. The thickness at the periphery may be reduced to suit the grade of the wheel; a soft grade requiring a wider surface in contact with the work. The greatest difficulty to contend with in grinding is the tendency of all emery wheels to heat the work. There are two remedies for this trouble, one is a liberal use of water on the work while grinding, and the other lies in the use of soft emery wheels intelligently manipulated.

On fine surface work the aim should be to advance the wheel over the work as fast as is consistent with smoothness, increasing the speed of both wheel and work when necessary, taking very light cuts and going over the surface a number of times. This method distributes the heat evenly, and the wheel has less time to wear during its passage over the work. This particular method of grinding, we think, has not yet obtained the appreciation that it merits. It should always be borne in mind that a wheel is free cutting only in so far as its surface remains keen. A glazed wheel being one in which the cutting points are worn down without breaking away, and a wheel is said to be "filled up" when the particles of metal adhere to its surface, both conditions being largely caused by undue toughness of the cementing bond of the wheel, and partly caused by forcing the work too rapidly.

Soft and tenacious metals always tend to fill up a grinding wheel, but this difficulty is often overcome by scoring the surface of the wheel and rubbing off the periphery of the same with a coarse and hard emery rub stone, while moving the wheel by hand.

Engineering Bureau in Lancashire.

In the engineering trades generally throughout Lancashire there is a gradual though slow improvement in the several branches in the various districts, though nowhere is there that general activity that could be wished. Boilermakers are better supplied with work than they have been for some time past. Some of the machine toolmakers are also fairly busy, but others, which depend mainly upon home trade, are not so well off for work. The heavy stationary engine builders continue to be well employed, and several of the large cotton industry machinists have recently secured good orders, both for home and abroad. Some of the special branches of engineering, such as hydraulic and electrical engineers, are also fairly well off for work. The general branches are still quiet, and the average condition is only moderate, not really active, though the year is still young. On the whole, however, the prospects improve, and the outlook must be regarded as tolerably favorable. There is over the district a general absence of labor disputes in those branches of industry, and in the cognate trades, possibly due to the fact that the employers generally have abstained from reductions in wages during the depression. In the iron trade there is a recurrence of

dullness, a lull in the buying for the present. Users have secured what they want for present purposes, and will not buy ahead at advanced rates. Makers hold firmly by the late rates, but business is reported to be done by merchants below those rates. Some buyers are said to be holding back for more favorable terms. One large order for pig-iron seems to be in this category. But makers are well sold for the next month or two, and, therefore, there is not much probability of lower rates for the present. The only iron that can be offered under the quoted rates is some that is held by others than makers, and this quantity does not appear to be large. District brands are, however, rather more plentiful, for the output has been larger of late. Some outside brands are being sold under the makers' quoted rates. Only a moderate amount of business is being done in finished iron, and there is a difficulty in maintaining the rates, though they are held pretty firmly in most cases. The steel trade appears to be a little less firm, but in the manufacturing branches the tendency is towards higher rates. The nut and bolt trades are but indifferently off for orders, and there is keen competition for any that come into the market. The metal trades generally are quiet, only a limited amount of buying going on. On the whole, the iron and steel trades have scarcely realized what was expected a short time ago, though it can hardly be said that there has been any retrograde movement in any particular branch. In the labor world all these branches are quiet, there being no signs of any movement in any direction. Peace may mean progress for all.—*Engineering.*

Bench Forming Lathe.

We have illustrated in these columns a forming lathe built by the Meriden Machine Tool Co., of Meriden, Conn.

The present illustration is of a similar lathe, but designed to stand upon a bench, and to do a line of work smaller in diameter, especially where its character is such as to require no support such as is afforded by the foot-stock on the regular lathe first referred to.

All chucks and tools will interchange with the regular lathes, and on such work as does not require the support of a foot-block spindle, and which is not over about 1¼ inches in diameter. This will do as much as the regular lathes.

The bench lathe will turn to 1⅝ inches diameter, but for work as large as this, the regular lathe is recommended, because being heavier and stiffer, it can be crowded more, and consequently will turn out more of the larger work. The piece shown in the cut is a safe hinge tip, and is held on the expanding chuck by means of a sleeve cast on for the purpose, and is cut off this sleeve by the cutting-off tool shown mounted on the top of the forming tool, after it is turned, the tightening of the chuck, turning, and cutting-off being done by a single motion of the one lever shown, and at the rate of 5,000 in 10 hours, ready to plate.

The bench lathe is also adapted to light brass work, by the addition of a longitudinal adjustment of the tool carriage, by means of a screw and wheel at the end of the bed. This is not shown in the cut, as it is not needed on soft metal work, for which the bench lathes are mostly used, as the larger lathe is recommended for brass work.

Professor—"We have several special courses, and the one you are to choose must depend on the trade or profession you desire to follow." Aspiring Youth—"My father wants me to be a bridge-builder, but I should like to be a dramatist." Professor—"Very well; take the course of mechanical engineering. That will fit you for both."—*Street & Smith's Good News.*

The above is the paragrapher's way of alluding to the fact that there seems of late to be a tendency to employ upon the stage more machinery than actors.

Twenty-two-inch Engine Lathe.

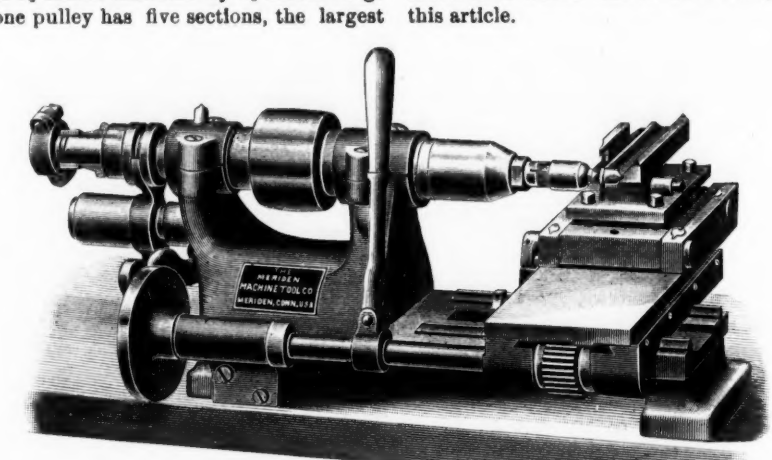
We illustrate herewith a new 22-inch lathe recently brought out by the F. E. Reed Co., Worcester, Mass.

It will be noticed from the engraving that the bed is of unusual depth for a lathe of this size, and it is thoroughly tied together.

The outside Vs are larger than usual and larger than the inner ones to give extra wearing surface for the carriage.

The live spindle is made from a crucible steel forging, and runs in boxes made of cast-iron, lined with genuine babbitt metal, which is put into the boxes in such a manner that it cannot work loose. The front bearing is 3¼ inches diameter by 6⅞ inches long.

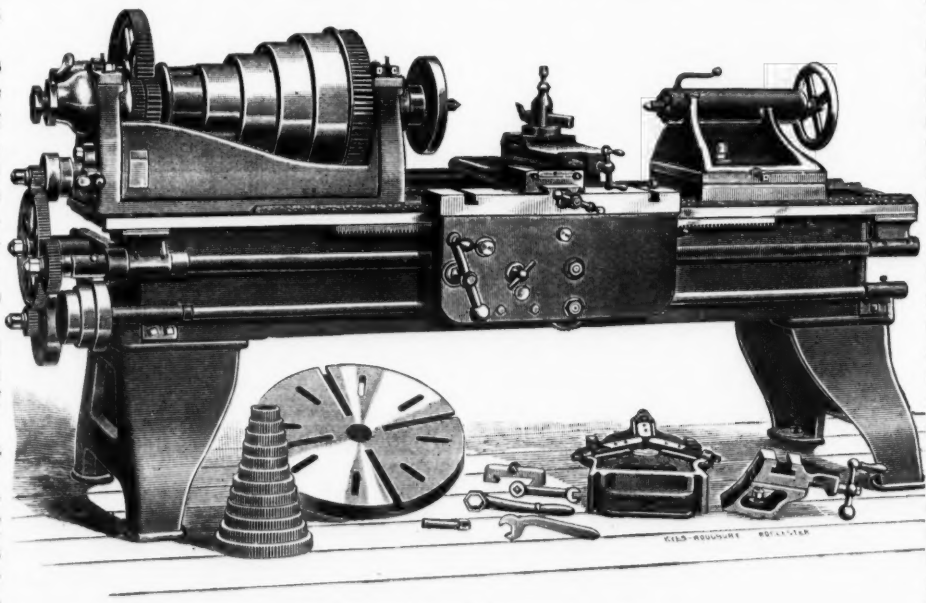
Cone pulley has five sections, the largest



Bench Forming Lathe.

of which is 14¾ inches diameter for a 3¼ inch belt, and the spindle is strongly back-geared, special care being taken to have the gears run smoothly.

Carriage has long bearings on the Vs, and is gibbed front and back. Feed works are driven by an independent rod and patent friction feed, and by a patent variable feed, so that a large range of feed can be obtained. The power cross-feed is so arranged that the gearing does not lock in with the carriage feed and break out the teeth of the gearing in case both feeds are put in operation at the same time. Lead-screw is made of steel, operated in connection with an open and shut nut. Rack pinion is arranged to disengage from the rack when lathe is used for cutting screws. Foot-stock is stiff



Twenty-two-inch Engine Lathe.

and strong, has a long bearing on the bed, and carries a spindle of ample size.

Countershaft pulleys can be oiled while running and without removing the belts. With 10-foot bed the lathe weighs 4,050 pounds.

Our readers will be glad to know that the continuous and phenomenal success of Messrs. Angus Sinclair and John A. Hill with their journal, *Locomotive Engineering*, has compelled them to seek more roomy quarters for the transaction of their business, which they have found in the new and elegant building at 256 Broadway.

Late Experiments Approaching "Center Blast."

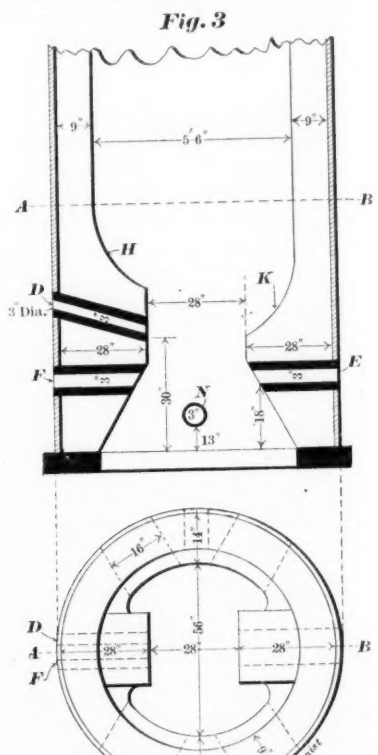
By Thos. D. West.

In the American Machinist of March 8, 1894, the writer, in answer to an inquiry from P. C. Forrester touching the subject of a "cold center" and center blast, called some attention to the closing in of the lining of a cupola over the tuyeres in order to bring the blast toward the center, but as the subject of the above article referred to was more for the purpose of setting forth the conditions necessary to "long heats" or steady running of a cupola, I did not dwell upon the question of contracting cupolas as much as I would like to have done, hence this article.

About nine months ago, after having given the "bottom center blast" the trial illustrated in the American Machinist of November 2, 1893, the writer concluded to give his attention to the formation of a cupola's lining with a view to learn if the same results could not be attained by a contraction or a protrusion of the inner walls of the linings just over the tuyeres. The first experiment which I tried was to bring in the lining all around the cupola over the tuyere, about as shown at *B* in the American Machinist of March 8, 1894, or in the accompanying "cut," Fig. 4, at *M*. This plan showed quite an improvement in the matter of greater economy in fuel, saving of lining and faster melting over the straight cupola. But feeling a nearer approach to the center with a forcible blast would farther increase or add to the utility of the above three points, I remodeled the shape of the lining after the plan illustrated by the cut seen at Fig. 3. This plan I continued using for about six months with very satisfactory results, attaining closely the results I did with the "bottom center blast tuyere" shown in the issue of November 2, 1893.

By an examination of the plan, which shows a section through *A B*, there will be seen two projections extending out 18″ from the inner surface of the lining, the one on the side at *A* standing higher than on the side *B*. The side *A* or projection *H* was carried up higher for the purpose of having an upper tuyere *D* to aid reaching the center with a blast to blend with that blown in at the tuyeres *E* and *F* to attain the end sought by "upper tuyeres." The only objection we found to this plan was the repairs necessary at every heat to keep the point at *H* in right form, owing to its being so close to the "melting point." The lower tuyere projection *K* called for but little repair, as at the end of six months' runnings of three heats a week it showed

Fig. 3



but little wear. Some might think that bringing in a cupola so radically as illustrated in this case would have a tendency to "bung up" a cupola. To start, we would say we found no difficulty on this score with our weight of heats, and to explain why it might for some be well to discuss the logic of practice followed. In this formation it will be seen that the area at the height of the lower tuyeres gave a form of 28 inches by 56 inches, which, when taken into consideration, left an area in proportion to that above the projections *K* and *M* ample to insure successful working as long as the cupola was slagged out properly, and which is an element calling for practice in any form of a cupola where long heats are necessary. Slag getting into cupolas, tuyeres, or reaching their level chills very readily from the effects of a cold blast blowing into or on it, and would soon "bung up" any form of a cupola if not run off as fast as accumulated. Of course, if a heat is a light one for the size cupola used, it is not really necessary in any case to go to the expense of "slagging out," but in a size of cupola shown, it is necessary after 20 tons to do "slagging." The heats we "run off" range from 40 to 60 tons, and after 10 tons are "run off"; we then open the slag hole *N* and before each tap let the slag run off.

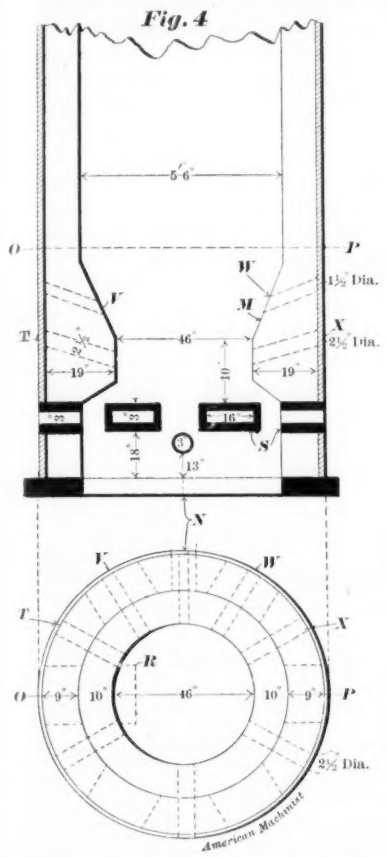
We are not now using the projection *H* or the upper tuyere *D*, but have fallen back on our original plan, as shown at *B* in the illustration of March 8, 1894, and experimenting how far it is advisable to carry this projection forward toward the center. In the cut *B* referred to above, we had a projection all around the cupola so that the diameter at the point shown at *M*, in Fig. 4 here presented, measured about 58 inches. A few weeks ago we remodeled the tuyere portion and are now working with the cupola lined, as shown at *M*, Fig. 4, and plan section of same through *O P*, and when this burns out so that re-lining is necessary we will close in more and continue doing so "little by little" until we find by trial how far it is practical with our weights of heats to extend the lining in over the tuyeres, as described in Fig. 4.

I would say we have not abandoned using the projection *K*, Fig. 3, but are using it in

connection with our latest plan, as shown by the dotted line at *R* seen in the plan view of Fig. 4.

This idea of contracting a cupola at the tuyeres cannot be said to be a new idea, for we find similar suggestions in the profiles of the "Gerhardi cupola," the "Ireland cupola," the "Woodward cupola" and the

Fig. 4



"Herberty cupola," the latter of which comes the nearest in design to approaching the principle here outlined in Fig. 4, but the plan of running out projections, as illustrated at *H* and *K*, Fig. 3, is entirely original with the writer as far as his knowledge goes, and I can say it has been effective in achieving commendable results.

The objection I would have to the "Ireland," "Gerhardi," and the "Woodward cupolas" is, that their lower tuyeres instead of being below the crown or projection *M*, as at *S*, seen in Fig. 4, are all up on a level with the smallest diameter of the cupola projection, something after the idea seen at *E*, in Fig. 3, or like that shown in Fig. 2, seen in the AMERICAN MACHINIST of March 8, 1894, and which as here used is not so objectionable for the reason there are only two tuyeres at the narrowest portion, whereas was the cupola brought in all around it so as to be the same diameter, and all the tuyeres were carried forward within circle with *K*, we would find conditions much more favorable to cause a cupola to bridge over right at and above the tuyeres, and for these reasons the advantage in locating the tuyeres below the crowns *K* and *M*, Figs. 3 and 4, when all are an equal distance from the center should be apparent, as this not only prevents the droppings of iron getting into them, but also affords a larger area of cupola space for chilling and bridging over. *T* and *X*, Fig. 4, show the position of upper tuyeres which the writer now uses in connection with the lower tuyeres, as shown, and I now think I shall put in another row, as seen at *V W*, Fig. 4, the next time we re line. Upper tuyeres do not cause "bunging up" or chilling of material in front of them like lower tuyeres, hence there is not the objection to them being placed at the narrowest portion of a cupola, as cited above, for lower tuyeres.

The time elapsed since writing this article and receiving the proof is about two weeks, and during that period we have been working with the cupola as seen at Fig. 4. Above, the reader will have noticed I state we will try bringing the cupola in still smaller than 46 inches over the tuyeres. I would now say we have reached the limit, and the longer I use it as shown at Fig. 4, the less satisfied I am with the results.

It did not work as well at the start as Fig. 3, but I did not know but it was mainly due to a very poor quality of coke received. Since obtaining a better article in fuel, I find but little improvement, and in a few days I shall remodel the cupola back to form Fig. 3, as with this plan, excepting the "bottom center blast tuyere" plan shown in the AMERICAN MACHINIST, November 2, 1893, I have obtained better all-around melting results than with any other principle which I have used for a large cupola.

The objection we find to plan Fig. 4 is, after about twenty tons are melted, it commences to rapidly clog between the top of the tuyeres and the underside of the projection thereby retarding melting, and in the morning it is a combined clog of coke iron and slag all around the cupola at the point *Y*, causing not only a loss of iron, but making extra labor for cleaning out and getting the cupola ready. For 20-ton heats it will work very well for such a size cupola, but for larger heats, the plan shown at Fig. 3 is much more preferable.

A New Taper Attachment.

We present herewith illustrations of a taper attachment for lathes which, though it resembles the Slate in its principle of operation, is so modified in construction and method of operation as to make it essentially new.

In this device the taper attachment moves with the carriage, and is thus always ready for use at any part of the bed, however long the latter may be.

The attachment consists essentially of a bracket which is bolted to the rear of the carriage, as shown in cross-section at Fig. 1, and in plan at Fig. 2. On this bracket a dovetailed slide is formed as shown, to which is fitted a bar, having an extension to the right, as shown in Fig. 2, by which

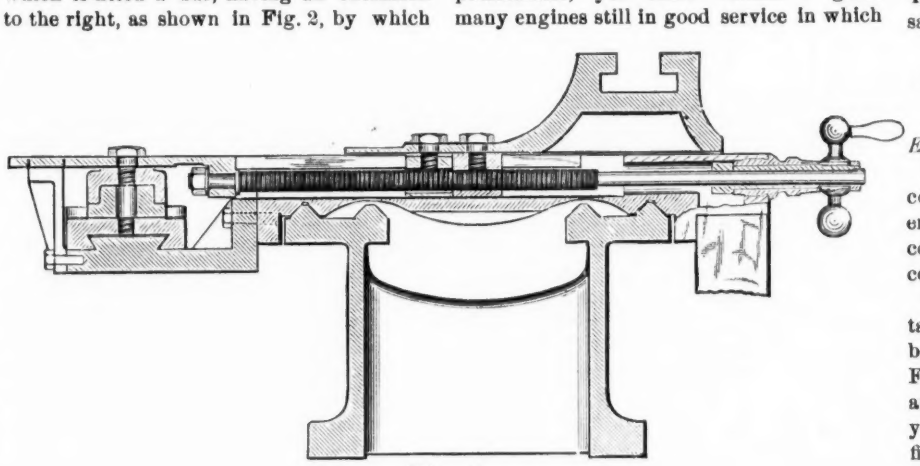


Fig. 1.

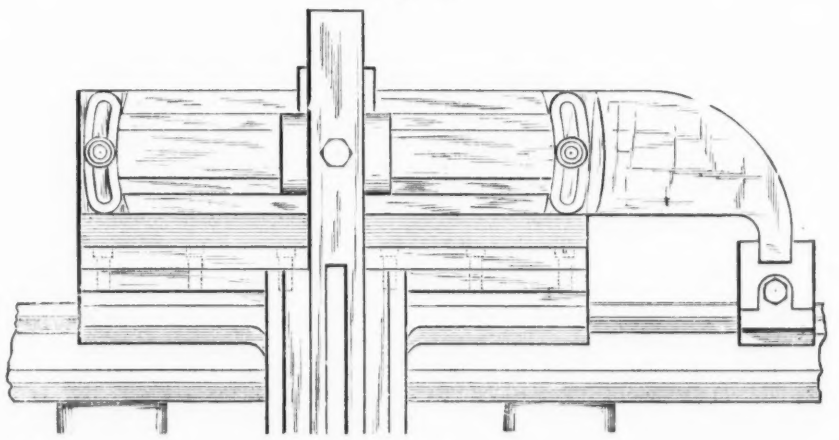


Fig. 2.

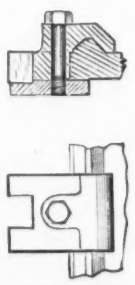


Fig. 3.

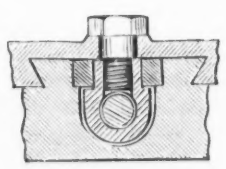


Fig. 4.

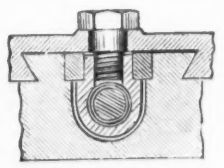


Fig. 5.

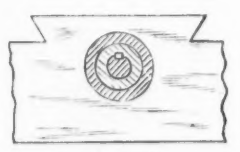


Fig. 6.

NEW TAPER ATTACHMENT.

it is connected to a sliding block (shown separately at Fig. 3) which can be clamped by a bolt to the rear V of the lathe. Above this bar, which is itself always parallel to the motion of the carriage, is another bar which swivels upon it to the desired angle, and sliding upon this is the usual block to which the cross-feed screw is connected, as shown in Fig. 1.

When the taper attachment is not in use the clamping screw, Figs. 2 and 3, is loose, and the whole device moves with the carriage without affecting the motion of the cross feed slide. But when the small sliding block at the right of the carriage, Figs. 2 and 3, is clamped to the lathe bed it holds the lower parallel bar (Fig. 1) first referred to, and also the taper bar above it, so that they do not move with the carriage, and consequently the cross feed screw and tool are moved in or out corresponding to the angle to which the bar is set. The cross-feed screw is splined into the sleeve gear in front, which gives the automatic cross-feed, and the crank handle is keyed to the same sleeve.

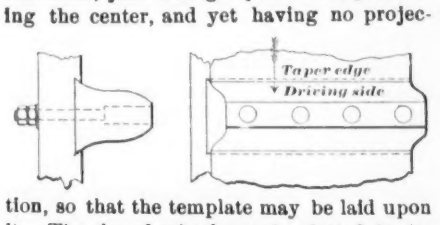
Fig. 4 shows the method of clamping the cross-feed nut to the block, and Fig. 5 the method of clamping the bar when desired; the clamping block in this case being bored out to clear the threads of the cross feed screw. Fig. 6 is a cross-section of cross-feed screw, sleeve gear and cross-feed bush.

Owing to the fact that this attachment is not fastened to the bed of lathe, except by the small clamping block it can be applied to the lathe without moving it. It is made by the Bradford Mill and Machine Tool Co., Cincinnati, O.

To Replace Teeth in a Spur Gear.

BY I. WHITEHEAD.

Though spur gears are not used as flywheels as much as they used to be when the great Centennial engine with its cut-gear connections exemplified its highest possibilities, yet there remain a great many engines still in good service in which they are used, and so it often occurs that the jack gear, or pinion, as well as the flywheel will break out some of its teeth, and it will pay to replace them rather than make a new gear. To do this we first make a template of tin to the shape of the end of a good tooth in wheel, allowing the template to extend one-tenth of the pitch below the base of the tooth and wide enough to form the fillet. Mark off the size of the dovetail proposed in the template upon the rim, allowing $\frac{1}{16}$ inch per foot taper on driving side, and the angle of side about 3 degrees. If the new tooth is forged in wrought-iron the ends may be squared to the length in the lathe, just truing up one end, preserving the center, and yet having no projec-



tion, so that the template may be laid upon it. The rim of wheel may be slotted in its place with a portable key-seating machine, or by hand, if not convenient to take it to the shop.

The tooth is first planed upon centers, first the dovetail, of which one side is planed parallel to the centers, while the other edge is tapered to $\frac{1}{16}$ inch per foot to fit slot. Planing parallel edge first, from it may be laid off the width of slot at the large and small ends, then pack up the center with surface gauge to the marks, thus planing it until it will fill the slot, allowing for driving up to a tight fit. The tooth may be scraped and filed to a fit, then spaced and laid off on its face in relation to the other teeth, then bedded in red lead and driven home.

Drill and ream through the tooth and rim of wheel to suit studs with heads countersunk about two-thirds depth of tooth and one-third the diameter of the thickness, and may be tapped into the rim or bolt through with check nuts on the inside as shown. The tooth may be cast of bronze, and so save some shaping.

LETTERS FROM PRACTICAL MEN.

The Limit of Age of Boilers.

Editor American Machinist:

I have been interested in the discussion concerning the limit of endurance of boilers, and the age where the line of safety comes in as far as the operation can be counted.

Mr. Wakeman's letters are always entertaining, but where the limit of age should be fixed cannot, in my judgment, be settled. For four years I have been called in to examine two boilers that were more than 40 years old; they had become so thin over the fires that my testing hammer would leave an indentation when struck anything like a smart blow, and the hammer certainly does not weigh more than six ounces. The pressure had been cut down until the sawyer cussed; at last, it was more pressure or new boilers. The competition was so keen in the lumber sawing that there was no money in sawing at the slow rate the mill had been cutting; they must have 100 pounds of steam to saw with. This settled the matter at once; the engineer, who was a good man and keen in his judgment, said: "These boilers won't stand any 100 pounds pressure."

I was sent for—four telegrams came a-jumping; I wondered what was the matter when they would send for me in the dead of a cold winter.

I went, took a brush and went over the boilers carefully, examined every inch of the boilers and every rivet and seam. I found seven cracks in the boilers and a crack in the back head 14 inches long, as clear and bright as new iron just cut.

In several places in the boilers I noted spots where the sheets were opening showing the grain of the iron, or, if you choose to so state, the strain of the metal.

The iron was as soft as lead, chips turning out of the sheets and bending quite easily; the metal had in the last two years worn quite rapidly, and the limit of supposed endurance had been reached.

The boilers have been taken out, but for 42 years they had been furnishing steam to build up the growing towns of the Northwest, and at last lay beside the Mississippi River rusting to death. In all these long years there has never been an explosion or a

rupture in any mill where these ancients had furnished the motive power—and they had furnished steam for seven months in almost every year without any kicking—and sometimes to men who called themselves engineers, yet who would load the old safety valves clear down so as to give them a little more steam.

In the 25 years' experience as an engineer I have known of boilers that have run 21 years furnishing steam night and day except Sundays. I ran a steam plant from 1869 until 1884, containing a battery of boilers that for nine months in the year had steam on them all the time except Sundays, when they were taken out because the firm wanted more steam; a pair of large Otis steel boilers were put in and exploded within two years by the man who had been my assistant.

There is a limit to the endurance of steam boilers, and, in my judgment, the engineer who takes a pride in his work is the best judge of any weakness coming to his boilers; he is with them day after day, knows the varying conditions under which boilers are working, and is not reckless in the management of them. A good engineer knows that he has only one life and don't want to have that cut off. The only need of an inspection by any authorized authority is the disposition of the owners and their agents "to do just as they like with their own property."

A competent engineer is by far the best inspector of his steam boilers and connections; the inspector comes once or perhaps twice a year and looks over the boilers, and perhaps does not stay with them more than half an hour. Ten boilers each day is their number for a day's inspection.

"Norman."

"The Personnel of the Navy."

Editor American Machinist:

I notice in your issue of April 26th a letter from Mr. Guthrie, of Bethlehem, Pa , in which he takes exception to "petty officer's" complaint in your issue of April 5th, that he was not allowed to go on liberty with full pockets. Mr. Guthrie says, "It is well known that no man is less capable of managing his own affairs than the sailor or soldier on leave." I am aware that such is the tradition in the service, but I think Mr. Guthrie misses the point, which is, that a man having earned his pay is entitled to have it in his hand, and such is the ruling in civil courts.

"Petty officer" being, as I presume, a machinist, who had learned his trade on shore at his own expense, and not at Annapolis at the expense of the country, naturally took the on-shore view of the matter.

Regarding the "lack of capability for managing his own affairs," I presume he refers to holding on to money. I have known plenty of young commissioned officers, who would go through a three-years' cruise always in debt to, say a friendly paymaster's clerk, drawing their full pay up to the end of each month. The faculty of holding on to money—making safe and profitable investments after it is earned—is an extremely rare accomplishment among landsmen, as well as seamen. Mr. Guthrie can find plenty of wrecks of little fortunes, attempting to make them big, in his own locality, up and down the Lehigh Valley, on the coal, iron, zinc, slate, and railroad operations, that have been exploited there in the last 25 years.

Mr. Guthrie says, "It is *historically* certain (the italics are his) that the glorious victories of the navy were won by vessels manned by men who were kept under a stern and brutal discipline," and asks, "what caused the defeat of the 'Chesapeake' but the fact that Lawrence had no time to train and discipline his crew?" That may be the *historical* fact in the books which Mr. Guthrie has read, but in Boston Bay the *traditional* fact—I get it straight from my own father—is that Lawrence and all his officers were drunk, and entirely unfit to command a public vessel. Captain Broke, of H. B. M. frigate "Shannon," sent in a challenge, which arrived when the after part of the "Chesapeake" was filled with pot-valiant ardor. So the history was made to suit the writers of the official reports, and the "undisciplined men" had to stand the racket. There are plenty of more modern instances of similar history making.

Coming down to a case within my own time, the "Kearsarge" and "Alabama" fought entirely under steam. Most of the leading officers of our ship I have been at one time or another personally acquainted with. Captain Winslow ascribed his victory to his "maneuvering"; Lieutenant Thornton to "the way the men handled the guns"; and the men were loyal to the flag, and commander and ship, because they were having a pleasant cruise with easy-going officers. The "maneuvering" was merely heading off the "Alabama," preventing her from running away by the superior steaming of the "Kearsarge," and the superior steaming was due to the fact that the engine room staff was made up of

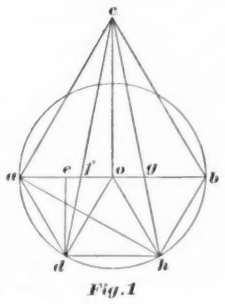


Fig.1

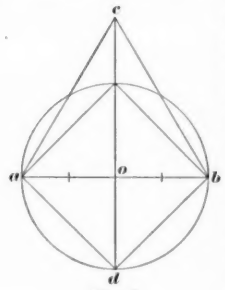


Fig.2

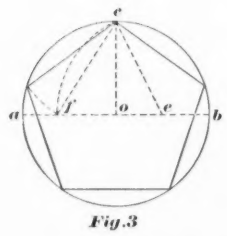


Fig.3

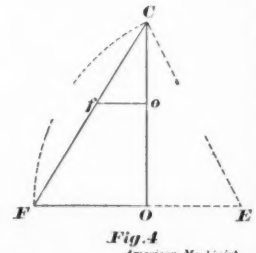


Fig.4
American Machinist

Regular Polygons.

zealous and intelligent young American mechanics, who were allowed to do their own work in their own way. The engines and men were kept up and improved when at sea, so that the ship beat all previous estimates regarding her speed.

The engines of the "Kearsarge" were an old design, and built with the meager facilities which this country afforded at that time for building screw propeller engines. The "Alabama's" engine was fully up to date—1863—and Laird Brothers had "a world-wide reputation" for their work.

The bragging and betting on the other side was overwhelmingly in favor of the British built ship, yet because her engine had been allowed to get down, she was outpointed and outshot by her opponent. If there be any in this country who really have any interest in our navy, beyond something merely to brag about, they may possibly take heed to this example.

The commander of the "Yorktown" would not allow "petty officer" to go on shore with his own money, but he would allow him on board ship to have immediate charge while on watch of a $100,000 worth of public property. If the place the man holds on board the ship is not attractive to him, whether the ship owes him money or not, it is better for the public that he remains away. On the first cruise of this same "Yorktown," the snapping of a connecting rod bolt on the high-pressure cylinder was instantly taken care of by the machinist on watch, who shut off the steam, preventing a fearful accident, and at the risk of his own life, as the starting gear is right alongside of the broken rod.

For an example of the losses which occur to a tax-paying country, through the high navy discipline, which Mr. Guthrie hopes "will never be relaxed," we have only to look back to last summer and read the reports of the loss of the first-class battleship "Victoria," flag-ship of Admiral Sir George Tryon, as set forth in the London papers of that time. Here was a man who was looked upon as "our ablest admiral," yet in a moment of weakness he attempted to swing two ships towards each other in a space hardly wide enough for one, the ships going at ten-knot speed on a pleasant afternoon for the purpose of mere drill. There were plenty of his immediate subordinates alongside of him, who saw instantly what would be the result before the signals were ran up, but their naval etiquette and discipline, and fear of this irascible old man prevented them from giving anything but very oblique hints as to danger, and he had, of course, his own wrong-headed way.

Admiral Tryon certainly did not intend to smash his ships together, and can only be charged with an error of judgment, but his second in command, Vice-Admiral Markham, on the "Camperdown," as his flag-ship, went into the collision, which he could easily have kept out of, understanding perfectly what the result must be, exhibited a case of most disloyal discipline. He said to the captain of his ship, "Johnson, one of these ships has got to be rammed, and we will be damned sure it is not this one." So he canted his bow so that he rammed the "Victoria," and she went down in 10 minutes with 20 officers and 340 men.

Before the court martial he pleaded that he had "obeyed orders," and was exonerated through that ancient nautical maxim, "Obey orders though you break the owners." From this distance it seems to me an extremely small hole for a Vice-Admiral of England to crawl out of. I had always supposed that they were men who were allowed to exercise some judgment of their own in a time of danger.

On board the "Victoria" after the ramming it was still "discipline." Instead of allowing every one to come up from below, time was lost in closing bulkhead doors, and trapping the unfortunate engine room force behind them, and getting collision mats over the bow, though the whole Mediterranean Sea was pouring in, yet the "drill" must be kept up and seven eighths of the crew were lost in consequence.

The most affecting thing of all was brave old Admiral Tryon, with all the pride shaken out of him, by this terrible result of all his drilling and discipline—for he said as simply as a little child, "it is all my fault," and—let us hope—humbly asking forgiveness of his Maker as he stood on the bridge awaiting the final plunge.

William H. Harrison,
Formerly 1st Asst. Eng'r, U. S. N.
Braintree, Mass.

Regular Polygons.

Editor American Machinist:

The rule for inscribing a regular polygon within a given circle, explained by your correspondent in your issue of April 5th, is strictly correct for the triangle, the square and the hexagon.

Let Fig. 1 be the given circle. On the diameter $a\,b$ as a base construct the equilateral triangle $a\,b\,c$; and on the radius $a\,o$ construct the equilateral triangle $a\,o\,d$. The point d falls on the circumference of the circle and is an angular point of the regular hexagon. The side of the triangle $a\,b\,c$ being double that of $a\,o\,d$, the altitude $o\,c = 2\,e\,d$. Join $c\,d$ intersecting $a\,b$ at f. The right-angled triangles $c\,o\,f$ and $d\,e\,f$ are proportional, and since the perpendicular $o\,c = 2\,e\,d$, the base $o\,f = 2\,e\,f$; *i. e.*, $o\,f$ is two-thirds of half the radius $o\,e$, or one-third of the radius $o\,a$. A similar construction gives the point g on the other side of the center, making $o\,g$ also one-third of the radius. The diameter is therefore divided into three equal parts at f and g.

Therefore, if we divide the diameter into three equal parts and draw $c\,f$ and produce it until it meets the circumference at d, the chord $a\,d$ will be a side of the regular hexagon. The point f is *two sixths* of the diameter from a, in conformity with the rule explained by your correspondent.

If we draw $c\,g$ through g *two thirds* of the diameter from a, and produce it until it meets the circumference at h, we obtain one of the angular points of the equilateral triangle which coincide with the alternate angular points of the hexagon, and the chord $a\,h$ is the length of the required side. That the rule is applicable to the square is apparent at a glance. Divide the diameter $a\,b$, Fig. 2, into four equal parts, and through the second point of division o, *i. e.*, the center of the circle, draw $c\,o\,d$ The chord $a\,d$ is the side of the inscribed square.

A true construction of the pentagon and decagon may be combined in one figure. Draw the diameter $a\,b$ and radius $o\,c$ (Fig. 3) perpendicular to each other. Bisect $o\,b$ at e. From the center e with the radius $e\,c$ draw the arc $c\,f$ intersecting $a\,b$ at f. The line joining $c\,f$ is the length of the side of the inscribed pentagon, and $o\,f$ that of the inscribed decagon. In the right-angled triangle $c\,o\,f$ — $\overline{c\,f}^2 = \overline{f\,o}^2 + \overline{o\,c}^2$, *i. e.*, *the square of the side of the pentagon is equal to the sum of the squares of the side of the decagon, and of the radius of the circle within which the figures are inscribed.* The point f divides the radius into extreme and mean ratio, *i. e.*, $\overline{o\,f}^2 = o\,a \times a\,f$. This construction is easily remembered and a little simpler than that which is given in the text books on geometry.* *To prove that f divides the radius into extreme and mean ratio.*

Calling the radius $o\,c = r$ $\therefore o\,e = \frac{r}{2}$

$\therefore e\,c = \sqrt{r^2 + \frac{r^2}{4}} = \frac{r}{2}\sqrt{5}$. But $e\,f = e\,c$

$\therefore o\,f = e\,f - o\,e = \frac{r}{2}\sqrt{5} - \frac{r}{2}$

And $f\,a = o\,a - o\,f = v -$

$$\left[\frac{r}{2}\sqrt{5} - \frac{r}{2}\right] = \frac{3\,r}{2} - \frac{r}{2}\sqrt{5}.$$

Now, if f divides $o\,a$ into extreme and mean ratio

$$f\,a : f\,o :: f\,o : o\,a, \text{ or}$$

$$\frac{3\,r}{2} - \frac{r}{2}\sqrt{5} : \frac{r}{2}\sqrt{5} - \frac{r}{2} :: \frac{r}{2}\sqrt{5} - \frac{r}{2} : r,$$

i. e., $\frac{3\,r^2}{2} - \frac{r^2}{2}\sqrt{5} = \frac{5\,r^2}{4} - \frac{r^2}{2}\sqrt{5} + \frac{r^2}{4} = \frac{3\,r^2}{2} - \frac{r^2}{2}\sqrt{5}$ *Q. E. D.*

To prove that the square of the side of the pentagon is equal to the sum of the squares of the side of the decagon and of the radius of the circle.

An algebraic proof may be given, but the demonstration is lengthy. I will do it by trigonometry.

Calling the radius unity, the side of the decagon is equal to twice the sine of half the arc which the chord subtends $= 2\,sin.\ 18° = 0.618 +$. Similarly the side of the pentagon $= 2\,sin.\ 36° = 1.175 +$

$$\overline{1.175}^2 + = 1.382 +$$

$$1 + \overline{0.618}^2 = 1.382 +$$

If a large triangle $C\,O\,F$ proportional to $c\,o\,f$, Fig. 3, be constructed, it may be used for the determination of the lengths of the sides of the inscribed pentagon and decagon when the radius of the circumscribing circle is given as follows: From C lay off $C\,o$ equal to the given radius. Draw $o\,f$ parallel to $O\,F$. $C\,f$ and $o\,f$ are respectively equal to the sides of the pentagon and decagon.

The construction of the triangle $C\,O\,F$ is illustrated. The center E of the arc $C\,F$ is found by making $O\,E$ on the base produced equal to one-half of $C\,O$.

Frederic R. Honey.
New Haven, Conn.

A Strap Broke.

Editor American Machinist:

At the Remington Arms Co., Ilion, N. Y., on the 25th inst., at 8:15 P. M., the left side of the double Corliss engine (23x48) con-

* See Elementary Geometry, Chauvenet, p. 121; also the application to the construction of the decagon, p. 147.

necting rod strap, crank-pin end, opened out in round part and let the pin pass through and the engine taking steam on crank end, the piston went through the back head, breaking it into several pieces and taking every stud with it; also a half section of stuffing box was broken out. The noise was heard some distance away, otherwise no loss. INDICATOR.

The Shaw Locomotive Requires No Counterbalance.

Editor American Machinist:

I saw an item in the AMERICAN MACHINIST of April 12th in relation to counterbalancing locomotive engines, in which it says that "the whole matter of counterbalancing is tentative; a little more or less makes the engine run about right, and a little more or less goes. Perhaps putting the counterweights a little further ahead or behind might produce better results, but just what to do with it must be determined by trial." We have determined by trial years ago just what to do—take them out of the driving wheels, there is no other remedy; and unless man can overturn the laws of motion fixed by the Creator of the universe, he will not accomplish the object sought.

If any one should try and lift himself over the fence in a basket by taking hold of the handles, we should say he was a little off, but no more so than the man who attempts to balance a locomotive under different conditions, as is the case with our present engines, and the sooner that is understood the sooner we shall arrive at the true solution of this subject. In these times we must keep up with the procession, and not get too far behind.

HENRY F. SHAW, M. E.

Boston, Mass.

Welding Screws—Plug and Ring Gauges—Thread-tool Gauges.

Editor American Machinist:

Will you explain or present to the readers of your valuable paper for explanation, a way to lengthen a screw by welding an extension to one end?

Either a splice or lap weld would, no doubt, distort the thread by changing the lead or reducing the diameter, and a butt

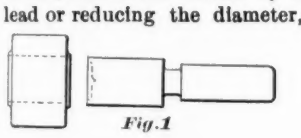


Fig.1

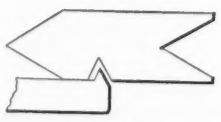


Fig.2

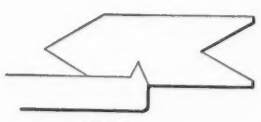


Fig.3

American Machinist

weld by electricity is out of the question in most blacksmith 'shops. Of course, an extension could be made by machine work, but can it be done by welding, the screw in question to be made of steel?

In making plug and ring gauges, the projections on the ends (Fig. 1), left to be ground off after lapping to size, break in hardening. How can pieces of this shape be hardened with small liability of breaking?

In grinding small inside thread tools, the gauges in common use touch the shank of the tool before coming in contact with the cutting edge, as at Fig. 2. Some grind to a tap, but that way is unsatisfactory. By filing gauge away, as shown at Fig. 3, it can be used on small thread tools to advantage. This is not new or original with me, but perhaps it is new to some. W. R G.

Calipering.

Editor American Machinist:

There are numbers of workmen who have become so accustomed to the use of vernier and micrometer calipers, for close work, that they would be surprised to learn (if they would make the test carefully) how close they could work with ordinary riveted or spring calipers.

The calipers should be beveled, so as to bear on the inside points, as it is essential to know *just* where to apply inside calipers or wires used for transferring measurements.

Having a plug; to turn a piece of work a given size larger, procure packing to the amount required, and place between one end of the calipers and plug, and set calipers to turn work by. To turn a piece of work a given amount smaller than the plug, set calipers to the plug, and put packing between the calipers and work. Of course, this would require the use of a micrometer caliper of small size to caliper packing with.

It is obvious that holes could be calipered a given amount larger or smaller than a given hole, the same way. As an example in calipering work, required to turn a piece of shaft that will shrink in a hole 4 inches in diameter.

The rule for shrinkage fits is .002 inch to the inch in diameter.

Procure a wire which fills the hole, or turn a short distance on end of shaft, to exactly fill the hole.

Procure packing to the amount of .008 inch (plus a small amount, in order to allow for filing out the tool marks) set calipers to plug, with packings between one end of calipers, and they are set to caliper work, with no guess-work about it.

It is a good plan for those workmen who always depend on vernier and micrometer calipers, to become familiar with the correct use of the common calipers, as then they would be able to do a good job with either.

J. T. G.

The Accuracy of the Planimeter.

Editor American Machinist:

Complying with the request of Mr. P. Barnes, in your issue of April 12th, will say, I am not so skeptical as to the accuracy of the planimeter, as my remarks on this subject may imply. The *matter* is not so much with the instrument as with those who use it. The same may be true of the indicator and also the slide rule. The trustworthiness of all these appliances, when properly manipulated, doubtless meets the purposes for which they were intended. One of your able contributors recently stated, in speaking of the indicator, that probably not more than half the cards taken were reliable exponents of the engine's work. In civil engineering, especially, the slide rule has a wide range of application, and yet, from good authority we have it that its chief utility is found in verifying calculations which are made in the usual way, thus making one method act as a check on the other.

Everything these days of a mechanical nature tends toward accurate methods of doing things. I well remember receiving a word of reproof from the foreman, when an apprentice in a machine shop. Some work had evidently been slightingly done. I remarked that "it was pretty nearly right." To this he replied that "pretty near was only half."

The term accuracy has a wide range, differing according to the various conceptions of what the word implies. I recently remarked on the difficulty of making holes in castings exact by means of cores. The reply came sharply, "——, a foundryman, could do it exactly."

I have always taken pride in having a steady hand, but must confess my inability to trace out an indicator diagram with a planimeter twice alike. The discrepancies were not enough to seriously affect the calculation, and doubtless came "within the clearly marked limits of its application," though I do not know how far these extend. Every one familiar with the indicator doubtless knows that the weighing method of arriving at the area of cards was sometimes used before the planimeter came into use, it only being necessary to balance a carefully clipped card with a rectangular slip cut from the same paper, and of equal length with the card. Of course, the scales used must be both delicate and accurate. The most satisfactory method of testing the planimeter which I have employed, has been to cut from drawing paper of a heavy quality, a rectangular figure, or a circular one, if desired, of definite dimensions, then enlarge the opening thus made by the diameter of the tracing point. The figure must not come within the travel of the planimeter wheel. Such an outline can be followed very accurately and serves to show the correctness of the instrument probably as nearly as the weighing method, which is rarely at hand. "QUIRK."

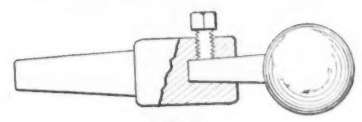


Fig.1

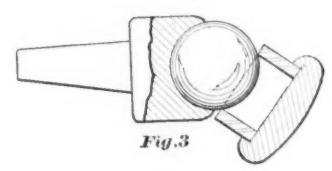


Fig.3

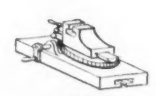


Fig.2

Making Balls for Check Valves.

Editor American Machinist:

Having had considerable experience in turning ball valves tempts me in answer to your request in your issue of April 19th to add my little to the general store, and although the process may not be new nor valuable, some good may come of it by bringing forth the ideas of others on the subject. At the time I speak of, our valves had a wide reputation, and were considered the best, which should argue somewhat in favor of our method of manufacture—we used no hollow balls, and they ranged in sizes only from ¾ inch to 1¾ inches. These balls are cast with a ⅝-inch lug projecting about 1½ inches, which is used to fasten them in an ordinary drill chuck (Fig. 1), with which all brass-turning lathes are provided. After they are chucked and trued up, which can be done with a slight tap of the hammer, they are turned off very accurately with a rest especially constructed for turning spheres (Fig. 2); they are then cut loose from the stems, and the tit left where cut loose smoothed down as nearly spherical as possible with a file; next a wooden chuck is made, as shown in Fig. 3, which encircles the ball about two-fifths, or enough to produce sufficient friction to rotate the ball while the special hand-tool shown in Fig. 4 is being used. This tool is simply a ring of steel bored and ground on the face, producing a good sharp cutting edge on the inner diameter, and is capped with a piece of wood to make it convenient for holding in the hand. This tool is moved around, while ball is rotating, in such a manner as to accurately scrape the whole surface exposed; the position of the ball must, of course, be shifted in the chuck from time to time. There are other methods, no doubt, of producing more cheaply, but we found this the best at that time for making check valves that would not leak, which was all we were after.

Plainfield, N. J. ROBSON C. GREER.

Blow-holes in Metals.

Editor American Machinist:

It would probably be out of place to say anything more, in an effort to convince Mr. Drake that the blow-holes in his castings are due to bad workmanship. I feel obliged, however, to say that they are, and quote the following in proof. He says: "Again, when we break the iron left in the runner box —— we find it full of blow-holes." This statement indicates that he is pouring his casting in or near the center; that his runner box is over a portion of the mold; that the iron in passing through the runner has generated steam and gas and driven it down through to the mold below; and that on the mold being filled up the vent was driven back, up through the cope, the runner box and the iron in it, and consequently caused the holes. If he will place a few handfuls of straw under the runner box before building it, he will, without doubt, find that the holes in the runner will disappear, and those in the casting also.

Mr. Drake has raised a question that has been shrouded in its share of mystery and old fogyism; and while the writer would rather some better authority would take the lead in this matter, I, nevertheless, feel compelled to define my idea of it, regardless of who gets hurt.

My observation of the action of metals leads me to say that there are metals that develop gases in the process of manipulation, that retain them when fluid, in the form of blow-holes, at temperatures approximating their melting points. In proof of this, I cite the cases of steel castings by the Bessemer process, certain brands of casting copper, and irons that are hard or approach purity.

Life in iron is that quality which admits of the mass remaining fluid a long time. It is due to the amount of total carbon with silicon in the iron, hence irons that are high in these elements are very fluid, and remain so for a long time, never show blow-holes and always turn out sound castings. On the other hand, as iron lacks these elements it becomes hard, has less life, and is more subject to blow-holes, because, from a lack of life, it sets too quickly to allow the gases entering it to pass off.

From the above I take it, that his iron is, generally speaking, a hard one; it must be, or it would not be full of holes; the holes, then, are due to the lack of elements or a condition that would cause the iron to remain fluid long enough to liberate the gases contracted in the pig bed. The iron he used previously was softer, had more life, and consequently gave less trouble from blow-holes, but, in my opinion, would not resist the same pressure in the boiler that the harder iron would.

It might be stated conditionally, that pig-iron showing a fracture full of holes, will produce a casting full of the same, minus those that have been liberated through agitation in handling; provided the iron has been melted low or dull in the furnace. If, however, the iron is melted high and hot the air-holes will be released, and in doing so, occasionally manifest it in the boiling in the ladles so often noticed in melting hard irons. In reply to the question, "Is it possible for blow-holes in castings to arise from some defect in the pig-iron from which they are made?" I would say no, most decidedly. For, as it is the nature of the iron to set quickly and imprison gases that may get in it, such characteristic cannot be considered a defect. If by defects he means an element or agency in the iron that originates these holes; no. If by defects he means sulphur absorbed in the process of melting, I would say, no, in the same vein.

The points I wish to make in particular are, that blow-holes in some metals and the harder irons owe their origin to manipulation or outside sources, and not to any agent common to or within the metal; that a condition of iron hot enough to liberate blow-holes is sufficient to prevent the transmission of a blow-hole from the pig to the casting; that sulphur in combination with the iron is diffused throughout the body, according to the life of the iron or to the length of time the body remains fluid; that while sulphur mixed with the sand in the pig bed or mold would cause holes, the sulphur in iron does not cause them, because it is distributed with a uniformity in the mass; its individuality is lost; it is not separate and detached, as is the case with air, steam and sand gases; that sulphur liberates itself by a process of liquefaction, common to elements that are so light compared to the specific gravity of the body itself; and, finally, that sulphur in solution with iron can cause blow-holes only as it decreases the fluidity or life of the metal.

Burlington, Ia. ALEX. CAIRNS.

Death of Birdsall Holly.

Birdsall Holly, of Lockport, N. Y., inventor of the Holly system of water-works and pumping engines, died at his home in Lockport on the 27th ult., after an illness of some months.

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English Plans for American Naval Vessels.

News comes from Washington to the effect that the new battleship "Texas" has developed so many serious defects during the course of building that those responsible for her construction have almost given up hope of ever making the vessel entirely satisfactory.

The plans of this vessel were purchased in England, and it is claimed that the delay in her completion (it is now about five years since the vessel's keel was laid) has been caused by the discovery of one weakness and fault after another, which had to be remedied before work could proceed. The latest discovery in this line was made when steam was turned onto the two barring engines, the frames of which immediately broke. Before this, and soon after the launch, the boiler foundations were discovered to be weak, and the vessel had to be put in dry dock to remedy this fault.

It seems to have been unnecessary for us to have paid for English naval vessel plans in view of our phenomenal ability to steal them, as set forth in *The Engineer*, but since all the vessels built here upon plans purchased in England have given trouble, while there has been very little trouble with the others, it will be seen to be the better plan for us to confine ourselves strictly to stealing; the test of construction showing that those English plans which we buy are worthless, while those we steal are fairly good.

Seriously, the simple fact is, however, that plans for anything which are transplanted are not likely to turn out successful. We think it is altogether likely that complete plans of our most successful naval vessels sent to England would seem to develop there very serious defects. Plans of complicated structures are always, or should be adapted to the equipment, methods and materials of the place in which the work is to be done, and English naval vessel plans can never be reasonably expected to be so successful when executed here by our methods, equipment and materials, as if executed at home, and the same could be said of any other plans made in whatsoever country.

"The Personnel of the Navy."

We publish elsewhere in this issue a letter on the above subject, written by one who, in addition to considerable personal experience in naval service, has made some study of naval matters. But as he—before entering the navy—had had considerable experience in civil life, he was able to resist the influence which tends to make men in the navy think that whatever the practice is there is right, and that it is sacrilege to doubt it.

Our own former comments upon the matter were made, it is true, from the standpoint of a landsman, but one who believes that "a man's a man for a' that," that when a man has honestly earned money it should be his to do as he pleases with it, unless he himself chooses to take the advice of friends regarding it.

Whether a man employed on a U. S. naval vessel is or is not capable of taking care of his own affairs, gives, so far as we can see, no other man the right to take care of them except by request of the incompetent or by appointment of a court, and it is just as certain as anything ever can be that so long as men employed on our naval vessels are submitted to the indignity of being compelled by an officer to take checks and seal them in letters in his presence, so long will it be practically impossible to get a sufficient number of the right kind of men for the service.

What machinist, for instance, who has read in this paper about the treatment of men aboard the "Yorktown" will think of going into the navy so long as anything else whatever can be found by which he can make a living? "Let justice be done though the heavens fall," is an old saying and one full of meaning. We do not believe that such rank injustice as we have alluded to is ever justifiable under any circumstances.

An Explanation of a Mystery.

In our issue of October 26, 1893, we called attention to some curious phenomena attending tests of armor plates and projectiles. Our comments at that time were called forth by the published results showing that, when a cannon was pointed at an armor plate and fired, whether it was the plate that was perforated while the projectile remained entirely uninjured, or, whether on the other hand the plate was scarcely marked, while the projectile was shattered, depended, in some mysterious way, upon whether it was plates or projectiles that were being tested at the time. Being acquainted with only one kind of machinery, *i. e.*, that made of steel and other metals, we could not penetrate the mysterious methods by which it seemed to be proven that we produced armor plates absolutely shot proof, and at the same time projectiles absolutely irresistible.

We are reminded of this by the charges now being made to the effect that the Carnegie Company has had some arrangement with manufacturers of projectiles, by which shot of special inferior kinds were furnished for testing Carnegie plates. This, if true, solves the mystery, and at present, we must confess, we can think of no other solution of it, though to make it complete, there should have been a reciprocity treaty by which specially weak plates were furnished when shells were to be tested.

Every few years some writer comes to the front to show that the increased use of machinery has had the effect of making times harder for working men. At first thought there seems some ground for this reasoning, but if it is so then there must be something radically wrong in the distribution of the products of industry. It is undoubtedly true that the first effect of a radical change having in its effect the cheapening of some product in which a good many men are engaged is bad for those so engaged, but the finality is, so it seems, that more men than ever before are employed in the given industry, and that the reduction in cost puts the product into so much more general use that more men than ever before are required to manufacture, and more enjoy the privileges of having the products of manufacture.

All these writers who tell us that machinery will put it out of the power of the working man to earn a living, lose sight of the fact that it is the working man who purchases these products, and that unless his ability to purchase is kept to the front there will be no use in manufacturing.

The prices of all the belongings of a steam plant are held at remarkably low prices, and those who fail to put them in complete order in these times will miss an opportunity they are not likely to find again for years. If steam engines are wanted the price is away down; the same is true of boilers and all engine and boiler belongings. It is true that it seems out of the way to spend money on a steam plant in dull times, but it will cost more when times get better, and there will be less time to spare for doing it. The place to begin to save money in a manufacturing business, and the way to encourage an engineer in the saving, is to furnish him with modern means for doing so.

The fact that our Philadelphia shipbuilders, the Cramps, have asked of the British Government the privilege of submitting bids upon two of the new vessels which that country proposes to build, would seem to have considerable significance, no matter from what standpoint it is viewed.

Upon the surface it looks as though the Cramps expected to be able to compete with the British shipbuilding concerns, a thing which has long been declared on both sides of the water to be impossible, though the Cramps have before declared their ability to do so.

To our contemporary, *The Engineer*, this request coming from American builders will undoubtedly seem nothing more than an attempt to get possession of the plans of an English vessel which could not be stolen.

The formation in New York of an association of manufacturers is announced. About 1,000 manufacturers, representing vast capital, are expected to be enrolled, and the organization is to look after the interests of members in a general way. The objects of the organization are not specifically stated, but it is thought much good will result from it, which, of course, will depend, as it does with every other organization, upon who directs and what its controlling spirit may be. The virtue or the evil of organizations does not follow from their formation merely, but from what they may do or not do after being formed.

Literary Notes.

THE MECHANICS OF HOISTING MACHINERY, including Accumulators, Excavators, and Pile Drivers. A Text-book for Technical Schools and a Guide for Practical Engineers. By Dr. Julius Weisbach and Prof. Gustav Herrmann. Authorized Translation from the Second German Edition, by Karl P. Dahlstrom, M. E., late Instructor of Mechanical Engineering at the Lehigh University. With 117 Illustrations.

This work is a translation made from Professor Herrmann's revised edition of Weisbach's work on "Engineering Mechanics," of which translations of several other volumes have already been published.

This book treats on all types of hoisting machinery. The subjects are handled in a theoretical and practical manner, making the book an excellent guide for all who have to design this class of machinery. The different chapters are devoted to levers and jacks; tackle and differential blocks; windlass, winches and lifts; hydraulic hoists, accumulators and pneumatic hoists; hoisting machinery for mines; cranes and shears; excavators and dredges; pile drivers. Although the work is intended for a text-book for technical schools, it will also be an exceedingly useful work in the hands of many practical men, and a valuable addition to the professional engineer's library. It is published by Macmillan & Co., 66 Fifth avenue, New York. Price of the book, $3.75.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(222) J. B. W., New York, gives his experience he has had with some stationary engines, and asks us to give our opinion of the merits of different types. We cannot do this; if he is not competent to decide for himself he must engage the services of a mechanical engineer.

(223) A. T. D., Louisville, Ky., writes: Please inform me what the proper ingredients are for black and yellow varnishes for patterns. *A.*—For the black varnish use lamp black, 1 part; shellac, 5 parts; methylated finish, 16 parts; all by weight. For the yellow varnish leave out the lamp black.

(224) M. R., Trenton, N. J., asks: Are machinists employed on board of vessels in U. S. Navy, or do they enter as engineers? *A.*—Machinists are employed on the naval vessels, but they do not enter the service as engineers; the latter are graduates from the U. S. Naval Academy. 2. Do machinists who are candidates for such positions have to pass an examination? *A.*—Yes. 3. What is the pay of machinists in the navy, and to whom should I apply for a position? *A.*—Apply to the chief engineer of any navy yard; he will also inform you of the pay of machinists.

(225) F. T. O., Lisle, N. Y., writes: I am requested to ask you if there is any difference in the steam pressure in a cylinder of an ordinary slide-valve engine and that

of the boiler. In a dispute I held that the pressure in the cylinder is only slightly less than that in the boiler, the decrease being due to friction. A friend of mine, who is an engineer, insists that the pressure in the cylinder is just one half of that in the boiler whether the engine is working at its full capacity or not. I claim the greater the power which the engine is developing the greater will be the pressure in the cylinder. *A*.—The greatest pressure in the cylinder is the initial pressure, and this is generally a little less than the boiler pressure; if the latter is, say, 100 pounds the initial pressure in the cylinder may reach 95 pounds; much depends on the length of the steam pipe, its diameter and the manner in which it is protected to prevent condensation. The initial pressure will never be one half the boiler pressure unless the steam is purposely throttled, or something is decidedly wrong in the construction of the plant. The mean effective pressure in the cylinder when the steam is worked expansively will increase when the power developed by the engine is increased. You are right; your friend is wrong.

(226) J. J. G., St. John, N. B., writes: We have a plain slide-valve engine with cylinder 12 inches diameter and 12 inches stroke; the engine runs at the rate of 130 revolutions per minute; boiler pressure from 50 to 60 pounds per square inch. The pulley on engine shaft is 36 inches diameter, the pulley on line shaft is 34 inches diameter, the line shaft is of steel 2¼ inches in diameter. We are now using about 10 horse-power. We have to increase our plant, requiring 30 horse-power more than at present. We have two boilers, but are using one only at present. Will the engine give us the required power? What change in the pulleys will be required? What should be the steam pressure in the boilers? Will the line shaft be large enough for the increase of power, and what size of belt will be required? *A*.—We should speed up the engine to 225 revolutions per minute, and use an initial pressure of 70 pounds per square inch. We should prefer a double belt 10 inches wide; no change in diameters of pulleys and line shaft is required. Of course, we assume that there are no pulleys on the line shaft so excessively large in diameter as to burst with the increase of speed. If the engine is of good construction there should be no difficulty in obtaining the increase of power. All depends on the steaming capacity and strength of the boilers, of which you have said nothing.

(227) G. C. M., Athens, Pa., writes: What would you consider to be the actual horse-power of a plain slide-valve engine, 9x14 inches; number of revolutions per minute, 150; boiler pressure, 100 pounds; steam cut off at ¾ stroke? *A*.—We should rate the actual horse-power at 41. 2. Can you give me a table of mean effective pressures in the cylinder for different boiler pressure and different points of cut-off? *A*.—We have no table of this kind on hand to send you. The mean effective pressure is easily computed by the following rule: Divide the length of stroke by the distance from the beginning of the stroke to the point of cut-off, the quotient will be the ratio of expansion. If, for instance, the stroke is 24 inches, and cut-off at 6 inches, the ratio of expansion will be 4. Find the hyperbolic logarithm of the ratio of expansion; this is easily found by referring to a table of logarithms which is given in any engineer's pocket-book; add 1 to the hyperbolic logarithm, and divide the sum by the ratio of expansion, and multiply the quotient by the absolute initial steam pressure. From this result subtract the absolute back pressure, the result will be the mean effective pressure. 3. How much should be deducted from the indicated horse-power to obtain the actual horse power? *A*.—From 15 to 25 per cent. 4. What is considered to be the lift of a centrifugal pump? Is it the distance from the water to the pump, or up to the mouth of the discharge pipe? *A*.—It is the distance from the water level to the center of the pump. For the horse-power required to drive a centrifugal pump, we should advise to write to the manufacturer of the pump.

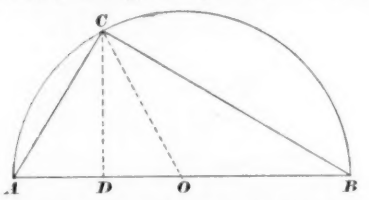
(228) F. F. K., New York, writes: Please inform me how to solve the following problem. The hypothenuse *A B* of a right-angled triangle is 22 inches long, the area of the triangle is 100 square inches, find the lengths of the sides *A C* and *B C*. *A*.—A right angled triangle can always be inscribed in a semi-circle whose diameter is equal to the hypothenuse of the triangle as shown in the accompanying figure. The first step will be to find the length of the line *C D* drawn from *C* perpendicular to the hypothenuse *A B*. Since the area of the triangle is equal to the product obtained by multiplying the length of *A B* by half the length of the perpendicular *C D*, we have for the length of *C D*

$$\frac{100 \times 2}{22} = 9.09 \text{ inches.}$$

Draw the radius *C O*, we then have a right angled triangle *C D O* whose hypothenuse *C O* is 11 inches, and the length of the side *C D* is 9.09 inches; from this data we can easily compute *D O* by subtracting the square of *C D* from the square of *C O*, and finding the square root of the remainder, which give us

$$\sqrt{11^2 - 9.09^2} = 6.19 \text{ inches for } D\ O.$$

Adding *D O* to *O B* we have
6.19 + 11 = 17.19 inches for the segment *D B*, and subtracting *D O* from *O A* we have 11 — 6.19 = 4.81 inches for the segment *A D*. Now, since *B C D* is a right-angled triangle, and since we know the lengths of *C D* and *D B*, the side *C B* is easily found by simply adding the square of *B D* to the



square of *C D* and extracting the square root of the sum, which gives us

$$\sqrt{17.19^2 + 9.09^2} = 19.44 \text{ inches}$$

for the length of the side *B C*. The length of the side *A C* is found in a similar way. *A C D* being a right-angled triangle whose sides *A D* and *D C* are known, we have

$$\sqrt{4.81^2 + 9.09^2} = 10.24 \text{ inches}$$

for the length of the side *A C*.

(229) J. M. I., East Farham, Canada, writes: Kindly inform me how to galvanize small castings? *A*.—Cleanse the articles in an ordinary chafing mill. When clean, heat them, and plunge one by one, while hot, into a liquid composed as follows: 10 pounds hydrochloric acid, and sufficient sheet zinc to make a saturated solution. In making this solution, when the evolution of gas has ceased, add muriate, or preferably sulphate of ammonia, 1 pound, and let it stand until dissolved. The castings should be so hot that when dipped in this solution, and instantly removed, they will immediately dry, leaving the surface crystallized like frost work on a window pane. Next plunge them, while hot, but perfectly dry, into a bath of melted zinc, previously skimming the oxide on the surface away, and throwing thereon a small amount of powdered sal-ammoniac. If the articles are very small, inclose them in a wrought-iron basket on a pole, and lower them into the metal. When this is done, shake off the superfluous metal and cast them into a vessel of water to prevent them from adhering when the zinc solidifies. 2. How is a pickle made to clean cast iron? *A*.—Vitriol, 1 part; water, 2 parts. Mix and lay on with a ladle or cloth tied in the form of a brush, enough to wet the surface well; after 8 or 10 hours wash off with water. 3. We use a No. 3 Sturtevant blower for a cupola. What would be the result if I reduce the speed so as to use it for a forge? *A*.—We referred this question to B. F. Sturtevant Company, who reply as follows: It is impossible to predict the exact result from reducing the speed of the blower, but it is certain that any considerable reduction in speed would result in failure to melt the iron in the cupola, owing to lack of blast. There should be no difficulty in reducing the pressure sufficiently for the forge, and at the same time reducing the work on the blower itself by putting a damper in its outlet pipe to be opened only enough to permit the requisite blast for forge. If this damper were closed tight, the blower would practically do no work, except that of friction, and would require but a small fraction of the power necessary to drive it when the outlet is wide open.

(230) W. D. F., Cleveland, O., writes: Please give me the formula used by the U. S. Government for bluing guns. I have some fine steel plates on which I want to get an even dark blue surface. Any information which will help me out will be appreciated. *A*.—An excellent method of bluing has been introduced into the National Armory at Springfield, within a few years, by Colonel Buffington, the commandant. It has proved so satisfactory in every respect that it has since been introduced into a number of private manufactories. The apparatus required for bluing by this method consists of a rectangular cast-iron tank of suitable dimensions. This is made rounding at all corners to diminish the liability of its cracking by expansion or contraction. It is permanently set over a furnace. The tanks in use at the armory are of sufficient size to hold a mixture of 20 pounds of black oxide of manganese, with 180 pounds of nitrate of potassium (200 pounds of the mixture in the proportion of 1 to 9) When a fire is built in the furnace, underneath the tank, the saltpeter melts, and the manganese settles to the bottom in a thick muddy sediment. When the workman is ready to commence operations, he stirs up the manganese, and then ascertains whether the bath is of the right temperature by throwing upon it a sprinkling of dry sawdust. If the conditions are right the sawdust will instantly sparkle and ignite, but if the bath is not quite hot enough the sawdust will glower for some time before taking fire. If the bath is of the proper temperature, the work—which must be assuredly dry—is immersed in it and allowed to remain there until it is heated to the same temperature. If it is tempered work, it is plunged for a few seconds into cold water, to set the temperature, as soon as it is taken from the heating bath. In case the work is not tempered, this plunge is omitted. It is then dipped into boiling hot water for a moment, and then immersed in a tank of oil. When it is cool it is removed from the oil, allowed to drain, and subsequently wiped off; it is found to be of beautiful dark blue, of greater depth and permanence than that obtained by other processes Either iron or steel is thus blued. Great caution is exercised to prevent the niter from coming in contact with the fire, on account of its expansive and explosive nature. The tanks are removed as soon as any sign of cracking appears and others are substituted in their place. In order to produce the best results it is necessary that the surface shall be made thoroughly clean. If a piece of highly polished steel is simply touched with the uncovered hand, there will be an impression left upon it, which will show after it is blued, unless the imperceptible stain is removed before heat is applied. There are other processes for bluing steel described in an article by B F. Spalding, which you will find in our issue of October 2, 1890.

(231) C. F. B., Rahway, N. J., writes: Please inform me how I can determine the size of upright posts supporting a water tank or tower of known weight, and taking the wind pressure into consideration. *A*.—The wind pressure will have the same effect on each post as a force acting at the top of the post and perpendicular to it, tending to bend the post and breaking it off at the bottom, hence as far as wind pressure is concerned, we may treat the post as a cantilever loaded at one end, and find the compressive stress on its outer fibers. To this we must add the compression due to the weight of the tank, and if the total stress does not exceed, say, 1,000 pounds per square inch of section for wood, or 5,000 to 6,000 pounds for cast iron, the post will be strong enough for the work it has to do. To find the force due to the wind acting on the posts, multiply the area in square feet of the larger surface of the rectangular tank by the pressure per square foot due to the wind—probably 40 pounds per square foot will be a safe pressure to take. If the tank is circular in form, the pressure of the wind is generally taken to be half that which would be exerted on a plane surface of the same diametrical section. Divide this total wind pressure by the number of posts; the result will be the force assumed to be acting at the top of the post tending to bend it Suppose we find that this force is equal to 3,000 pounds, and that the post is 12 feet high and 15 inches square. From this data we compute the stress on those outer fibers of the post which are subjected to the greatest compressive stress. This stress is computed from the following general formula:

$$S = \frac{M \times c}{I}, \qquad (1)$$

in which S = stress per square inch on the outer fibers, M = the bending moment, c = the distance from the neutral axis to the fibers most remote from it, and I = moment of inertia. For square beams or posts I is equal to $\frac{b^4}{12}$, in which b = breadth in inches of a side of post, and $c = \frac{1}{2} b$. Substituting these values in formula (1) for the corresponding symbols, we have:

$$S = \frac{M \times \frac{1}{2} \times b}{\frac{b^4}{12}}$$

which reduces to

$$S = \frac{M \times 6}{b^3}. \qquad (2)$$

The bending moment is found by multiplying the length of the post in inches by the force acting at the end, hence:

$M = 144 \times 3{,}000 = 432{,}000$ inch-pounds.

The breadth of the side of the post is given as 15 inches. Substituting these values in formula (2) we have:

$$\frac{432\,000 \times 6}{15^3} = 766 \text{ pounds}$$

for the compressive stress on the outer fibers. This will leave us 1,000 — 766 = 234 pounds per square inch for simply supporting the weight of tank, or a total resistance of $15^2 \times 234 = 50{,}650$ pounds, which the post can exert in a vertical direction. If the load acting vertically downwards on each post exceeds this amount, the post will have to be made larger or the number increased. For iron columns we make precisely the same investigation of their strength, and be governed accordingly. Formula (1) is applicable to all forms of cross-sections by substituting the proper values for I and c, which are given in books treating on the strength of materials and in engineer's pocket-books.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila, Pa. See p. 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Speed Gage McLauthlin & Co., Fulton St, Boston.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St. N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Engine Castings, 1 to 6 Horse-power Vertical. Humphrey's Foundry, Bellefontaine, O.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

"Management of Corliss Engines"; post free, $1. Spon & Chamberlain, 12 Cortlandt street, New York.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

American Packing Rings make pistons steam tight. Are simple, durable and inexpensive; write for circular. J. H. Dunbar, Youngstown, O.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

Grinders' Supplies—Emery, Emery Wheels, Grinders, Knife Powders and Sharpeners, Paste & Liquid Polish, Whetstones. The Tanite Co. New York, N. Y.; Cincinnati, O., & Stroudsburg, Pa.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid Published by John Wiley & Sons, 53 East Tenth street, New York.

The Polar Planimeter.

BY WM. COX.

It is not my intention in these lines to describe the theory of the polar planimeter or the methods of using it, but rather to show from the experience of those who have devoted years to the study and use of this ingenious device (as well as from my own) that it is, notwithstanding the doubts which have been recently raised as to its veracity, deserving of every credence.

It must at the outset, however, be clearly borne in mind that there are planimeters ranging all the way up from five to one hundred dollars each, and even more, so that the confidence which may be placed in them must evidently depend largely upon their style, principles of construction, quality and consequent price. My remarks will have reference mainly to the instrument represented in the figure, this style being most suitable for civil or mechanical engineering work, as its quality is of the best, and the movable or tracer arm is finely graduated throughout almost its whole length, so that it may be adjusted that the actual area of any given surface, represented by a drawing made to any scale, may be easily obtained.

The accuracy of the measurements made by means of the polar planimeter depends upon the care exercised in passing the tracer round the outline of the figure whose area is required, and also upon the care bestowed upon the construction and adjustment of the several parts of the instrument. There is, however, another factor which also materially affects the accuracy of the results, and, that is, the surface of the paper upon which the planimeter is used. The instrument is of necessity a delicately con-

structed one, and the measuring record being obtained by the *independent* rolling or slipping of the wheel, as well as by its *combined* rolling and slipping, the surface over which it travels must evidently affect more or less the regularity of its progress, increasing the record in some cases, and diminishing it in others.

To test in a general way the accuracy of this planimeter, as well as to facilitate the adjustment of the tracer arm in accordance with the scale to which the drawing is made, a small, round, brass disk is usually furnished with the instrument, having a fine groove round its edge inclosing a given and known area, such as 4 square inches. The tracer can be carried with considerable precision round the disk by means of this groove, and the record of the wheel compared with the known area encircled by the groove. A few trials both forwards and backwards will enable the degree of accuracy obtainable to be easily ascertained. In some cases a small strip of metal is used instead of the groove, having a fine center pin at one end, and holes at 1, 2, 3, etc., inches, from it, in which the tracer point can be inserted, and thus made to describe an accurate circle of 2, 4, 6, etc., inches, diameter, the record of the wheel being then compared with the known area of such circles. Of course, when great accuracy is required, the mean of several revolutions of the tracer is taken, and the tracer arm adjusted to bring the mean reading as near as possible in accord with the known area of the circle. Thus, in one case when testing an instrument, I obtained the following consecutive records for each passage of the tracer round the disk: $4.18 + 4.175 + 4.178 + 4.170 + 4.180 + 4.172 = 25.055$; mean $= 4.176$. It will thus be seen that the greatest departures from the mean are $+ 0.004$ and $- 0.006$, being 0.10 and 0.12 per cent. The area of the disk used was 4.17 square inches, so that the mean record was very nearly correct, and could probably have been made still more so by a slight adjustment of the tracer arm. The greatest variation between *any two* records was only one in 417, or less than a quarter of 1 per cent.

Professor Franz Lorber, of Leoben, Austria, who has devoted a great deal of time to the examination of different kinds of planimeters, and made several thousands of careful and thorough tests of them, came to the conclusion that the error in the records is represented by an equation which may be reduced to the form of

$$E = Kf + m\sqrt{Ff},$$

where E = the error in the record expressed in terms of the area measured,
F = the actual area measured,
f = the value given to one turn of the measuring wheel, depending upon the setting of the tracer arm.

K and m are constants, varying with different kinds of instruments, being for such as represented in the figure, $K = 0.00126$, and $m = 0.00022$.

Professor Lorber prepared tables of the results of a number of his tests, the following referring to the planimeters I am considering:

Actual Area Measured = F.	Absolute Error in the Record = E.	Relative Error in the Record, f being = 100 Square Centimeters.	
Square Centimeters.	Square Centimeters.	One in	Per Cent.
200	0.157	1,274	0.0785
100	0 148	682	0.148
50	0.141	355	0.282
20	0.135	148	0.675
10	0.133	75	1.33
5	0.131	39	2.62

The above are the errors resulting from one single passage of the tracer point round the area to be measured, and not the mean of several passages. It will be noticed that the absolute errors, varying from 0.131 to 0.157 square centimeters, differ but slightly from one another, and are not all in proportion to the area measured, whereas, on the other hand, the relative error diminishes considerably, as the area measured is larger, being almost inversely proportionate to the increase of area.

Prof. Henry S. H. Shaw, in a valuable paper presented to the Institution of Civil Engineers, says: I know a civil engineer's office, where a large amount of earthwork quantities had to be taken out, the calculations proceeded slowly and with many repetitions, until one of the draftsmen procured a planimeter, and then the other, with the result of a great expedition, and the almost complete absence of errors—and even then only in decimal places—where previously the divergence had been as much as by units.

Mr. Clemens Herschell, C. E., in a paper contributed to the Journal of the Franklin Institute in 1874, after describing the method of mechanically calculating earthwork quantities according to the prismoidal formula, by means of the polar planimeter, says he finds that the probable error need not be greater than two yards in a thousand, or 0.2 of 1 per cent.

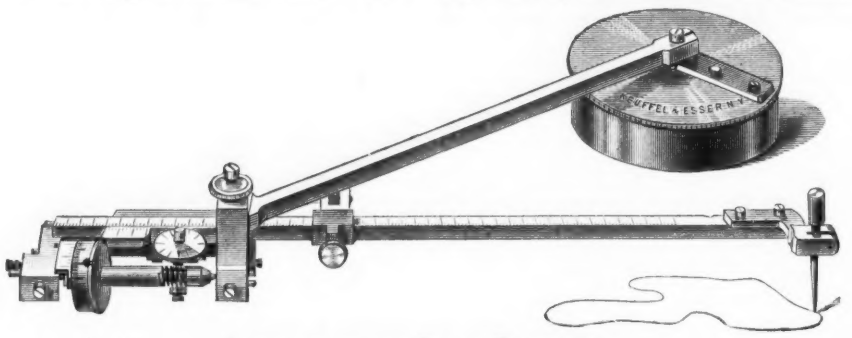
A correspondent of *Engineering News* sent a few months ago some particulars of work done by him with a planimeter same as herewith illustrated. He says: "Various articles on the use of the polar planimeter have appeared in your journal from time to time, but they were in the nature of descriptions and mathematical demonstrations of its workings, together with various formulas, and not comparisons of results in every-day practice. Engineers are seldom met with in railway construction that have ever used the planimeter for the computations of their estimates, or know anything about its advantages for such work. In the calculation of areas of complicated cross-section and overhaul for monthly estimates, where time is always a desideratum, it is to be highly recommended, and its accuracy is shown by the following comparison taken from actual practice on heavy railway construction in earth and rock where the work was done by steam shovels, and numerous cuttings were necessary to finish each cut.

Comparison of Results by Original Cross sections, Final Estimate and Polar Planimeter.

Excavation.	By Original Cross-section.	By Final Estimate.	By Polar Planimeter.	Difference.
	cu. yds.	cu. yds.	cu. yds.	%
Dalrymple cut...	61.164	61.196	60.871	— 0.52
Heine cut	52.801	52.801	51.763	— 1.96
Herrick cut.....	44.211	45.521	45.683	+ 0.35
Smith cut.....	43.947	43.223	43.088	— 0.31
Baker cut.....	116.647	113.510	114.502	+ 0.86

For overhaul in two cases, calculated by analytic and graphic methods: 1,419,187 cubic yards hauled 100 feet, planimeter made + 0.024 per cent. difference; 1,027,-839 cubic yards hauled 100 feet, planimeter made + 0.0316 per cent. difference."

I think I have said enough to show that reliance may be placed upon the results obtained by means of the polar planimeter, if before using the instrument it is carefully tested by means of the disk described,



Accuracy of the Polar Planimeter.

and correctly adjusted to the scale of the drawing. In the larger and more expensive instruments devices of one kind or another are adopted whereby the factor of the unequal surface of the paper may be more or less eliminated.

A Case of Small Pattern Work.

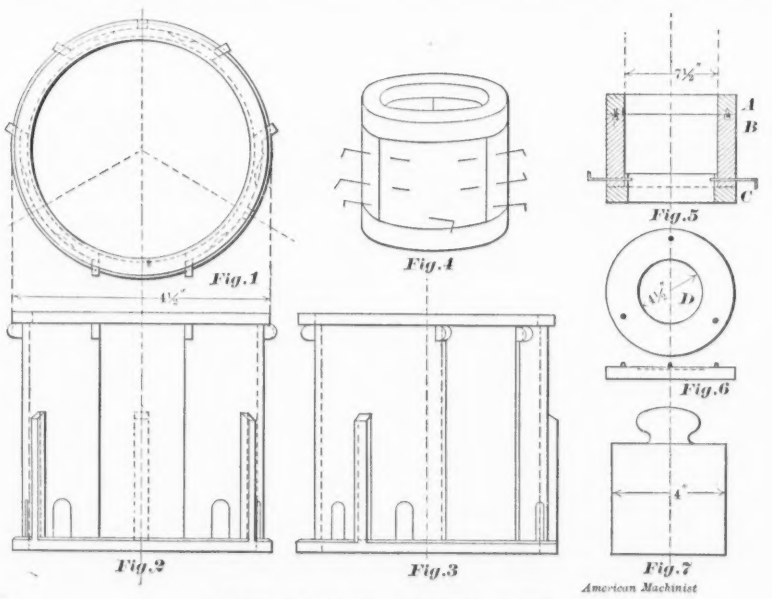
By John M. Richardson.

On somewhat rare occasions it happens that a pattern is of such a peculiar shape that it would be very difficult to mold in an ordinary flask, even by using cores, when by making a special flask the cores can be either wholly or partly dispensed with, and if the pattern is small the flask would, in nearly every instance, be cheaper than core-boxes.

As an illustration, take the piece shown in Figs. 1, 2, 3 which represents a circular drum used on a certain small complicated machine.

In this case it was necessary to cast it having all the openings and projections just as shown, and it will be noticed that all the rectangular holes, together with the little lugs or ears at the top, and also the vertical ribs, occur at thirds of the circumference, instead of at halves or quarters.

This, at the outset, renders it a very difficult matter to mold in an ordinary flask, owing to the coring which would be involved, so it was done in the manner I am about to describe, and without a core-box of any description.



A Case of Small Pattern Work.

The drum was first built up of segments $\frac{1}{8}$ inch thick, allowing a very generous margin on the diameters for subsequent operations.

After all the layers had been glued on, the sides were trimmed somewhat in the lathe, and then the piece was removed from the face-plate, and sawed vertically into three equal parts.

After each piece had been trimmed so that they all were perfect thirds of the circle or ring, they were glued together, having a piece of thin paper placed between each joint, and the whole was glued securely to the face-plate, having the joints match three lines, dividing the face-plate into three sections, making equal angles at the center. The paper was simply used so that the parts could be separated without injury after turning.

The drum was then turned down to its finished size, and the lines for the sides of the openings made while in the lathe, by inserting a scriber in the tool-post to the compound rest, and moving the work into the successive positions required.

The remainder of the work on the pattern requires no special mention, except that when finished it was in three detached sections or parts, each piece being exactly like the other two, and having no dowel pins or wires, this not seeming necessary.

We are now ready to examine the flask, which is somewhat out of the ordinary line, having a cope and nowel, and the middle section or cheek being in three equal parts and drawing off sideways.

As the pattern was so small it came more convenient to make the flask round as shown in Fig. 4.

Fig. 5 shows the parts in section, A being doweled to B. B is in three parts, and fastened together with rods as shown in Fig. 4, and C is fastened by rods also, which pass through B, and when removed the sides B can be taken away and the pattern extracted. The flask was still further held tightly in position by making a loop of a large belt lacing, passing it around B and tightening with a rod, using it as a twister.

Fig. 6 shows a bottom board, having dowel pins which fit the holes in the middle section B of flask, and having a depression D turned in the center $\frac{1}{16}$ or so deep, and the diameter of the pattern.

Fig. 7 shows a plug, or former, having a diameter equal to the internal diameter of pattern, to be used while ramming up.

The molding can be briefly outlined as follows: first, take the middle section of flask B with its three parts in position, and invert upon the bottom board; next, place the three parts of the pattern in the depression in the center of the board, and have the edges which meet just opposite the joints in the flask. The turned recess in the bottom board holds the pattern in position, so that dowels are not needed. Next place the plug, Fig. 7, into the pattern, and then place a piece of thin, tough paper between each division of pattern, extending it across and into the corresponding joint in the flask. This divides the flask into three distinct pockets, and answers the purpose of parting sand. Each one of these sections can now be filled; then remove the plug and fasten on the nowel C, and ram that. Turn the whole over, take off the bottom board, and ram up the cope.

To remove the pattern, lift off the cope, unfasten the cheek and nowel sections, draw away each of the three side parts, and the pattern is released in a very neat manner with scarcely any effort.

Light on Logarithms.

An expert engineer in a New England city rendered a bill to a corporation who had employed him to write a technical report. The amount of the fee was large, the corporation refused to pay it, and the claim was carried into court.

During the trial the counsel for the corporation sought to belittle the expert's work, raising questions as to his experience, and, in fact, to prove that his labor would have been amply rewarded with a few dollars a day.

"How did you reach this result?" asked the lawyer, referring to a certain calculation, which had involved the use of logarithms.

"I consulted Napier's table and"—but he got no further.

"You consulted Napier's table, did you?"

"Yes."

"Do you mean to tell this court that

you, an expert, had to resort to a published table? Did you prove the figures of that table?"

"No, but they have been proved. They are considered to be accurate by every scientific man."

"Why did you not work out your own table of logarithms? Is it not because you are unable to do so?"

"It is not. I am perfectly capable of preparing such a table, but it would have taken too long a time to do so, and so I consulted the standards."

"In order to prove your calculation as well as your capabilities in this matter," continued the suspicious lawyer, "I will now ask you to prepare a table of logarithms."

"Here and now?" inquired the plaintiff. "I fear it will consume too much of the court's time."

This seemed to confirm the lawyer's doubts, and so he insisted the more upon having a complete table of logarithms prepared.

The plaintiff smiled maliciously, took paper and pencil and began his work. In about five minutes the lawyer asked him if he had finished. The plaintiff shook his head and continued at work. Ten minutes passed by, and again the question was put:

"How nearly finished are you?"

"Very far from finished," remarked the plaintiff.

"Well, may I ask how long it will take you to prepare a table such as Napier's? You seem to be very slow about it."

The expert hesitated a little, and then replied: "I estimate that, working alone, I might be able to complete it in about fifteen years, working day and night. It took Napier and five assistants seven years to prepare his table, but I am less familiar with the calculation than he was, and, as you say, work slow. Still in fifteen years I think I can complete it."

It is unnecessary to say that the lawyer was not a little taken aback by the answer, which enlightened him a trifle on the subject. He withdrew the questions, and eventually the expert won his case.—*New York Herald.*

The Compound Engines at the Centennial.

BY FRED H. COLVIN.

Although both Mr. Hemenway and Professor Sweet have told us in excellent papers before the A. S. M. E. monthly meetings, and as published in the AMERICAN MACHINIST, that there were no compound engines at the Centennial of 1876, as a matter of fact there were three on exhibition. One was in either the Swedish or Norwegian exhibit, and another exhibited by Cramps, of Philadelphia, both of these being vertical compound condensing engines for marine work. Neither of these was in operation.

The third engine (perhaps it should have been mentioned first) was built by the People's Works, of Philadelphia, being designed and installed by Mr. John H. Cooper, M. E., to whom I am indebted for these facts and the following data:

It was a cross-compound engine, having cylinders 8x18 and 14x18 inches respectively, each cylinder being provided with plain slide valve, driven by separate eccentric from the main shaft. The high-pressure side did the governing, as is quite common to-day, and this governor had a safety stop to provide against the belt's slipping or sliding off, the simplicity of this stop making itself evident from the cut of the governor. The cylinders were thoroughly lagged but were not steam jacketed. The other sketch shows in outline the arrangement of the condenser under the low-pressure cylinder which for simplicity cannot be excelled, this plan being used by Mr. Porter in his engine at the Paris Exposition in 1867.

This condenser was placed beneath the low-pressure cylinder, and, as will be seen, is divided into three compartments, the condenser proper, the hot-well and the air-pump chamber. The valves are shown, one open to the air pump from the condenser, and the other closed from the air pump to the hot well. The air pump, which is a simple single-acting plunger pump, was connected to the low-pressure valve eccentric, and driven by it, at the same speed as the engine. It will be noticed that the pump is very small as compared with the chamber, and also that the quantity of water handled at each stroke is comparatively small with regard to the rise and fall of the surface of the water in the pump chamber.

This surface is the real piston of the air pump and the movement of the body of water is what forces the water of condensation into the hot well, and as this water piston needs no packing, one of the annoyances of an air pump has disappeared, for any leakage of the small pump does not affect the vacuum, the whole being submerged and almost self-packing.

A peculiarity of this engine was that both cranks were set at the same angle, or in exactly similar position on the shaft, so that both pistons moved in unison, the object being to avoid the side strain and twisting motion of cranks set at quarters.

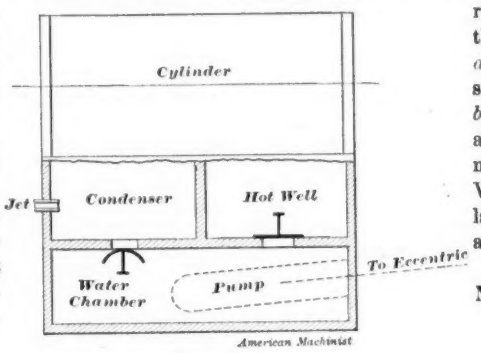


Fig. 1

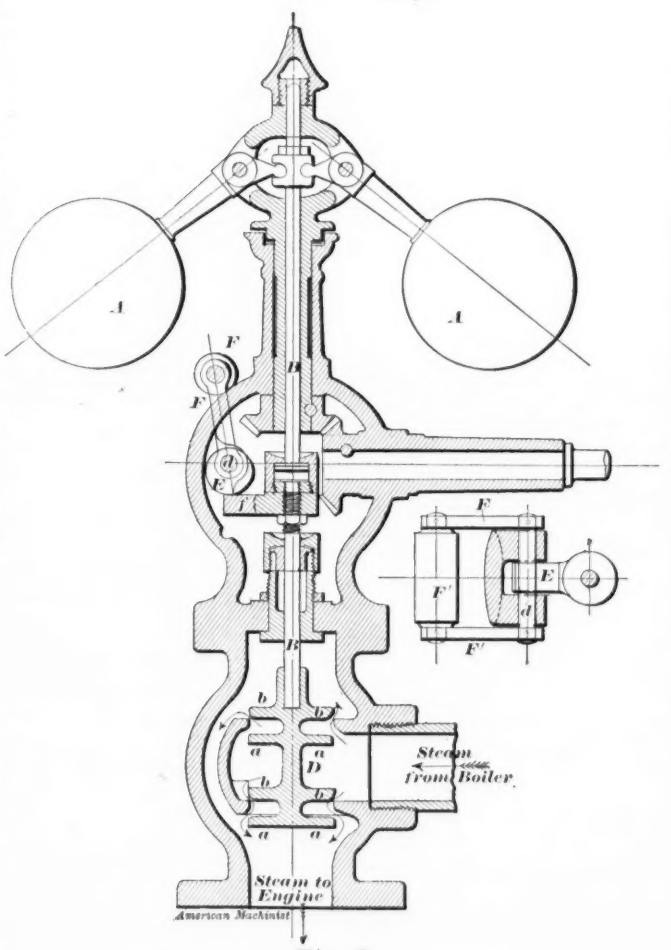


Fig. 2.

COMPOUND ENGINES AT THE CENTENNIAL.

The objection that it could not start from any position is met by referring to the many single engines running which need not be stopped on the center—are usually managed without, and there is no more need for the quartering of the cranks in this case. There was no receiver used, the exhaust pipe from the high-pressure cylinder going directly to the low, and taken as a whole the engine was an extremely simple design, the fewest parts possible being used, yet being complete in detail and doing good work at the exhibition—strange that it was overlooked by Mr. Hemenway and Professor Sweet.

But though small in size it was nevertheless a complete working compound condensing engine and deserves credit as such, as well as reflecting credit upon its designer for being progressive and fortunate enough to have the only compound engine under steam at the Centennial. It is believed also that *the year* 1876 *was the centennial of the compound engine;* for history tells us that in 1776 Jonathan Hornblower made his first models and experiments with compound engines, although it was not until several years later, 1781, that he took out his patents in this direction and made the matter public. So that besides being the only operative compound at the Centennial, Mr. Cooper's engine was also a Centennial commemoration of the first compound engine ever made, and deserves more than a passing notice in the history of stationary engines of America.

And it may be interesting to note that Mr. Cooper stood alone in the advocacy of compounding with such a simple construction, but was unable to carry out his ideas on account of few engines of the kind being in demand, the water necessary for condensation not being available. It was his favorite idea to so construct a compound engine that with its appropriate boiler the initial cost would not be more than a high-class automatic engine with its appropriate boiler, and being as economical of steam, would cost less for attendance and repairs, being much more simple.

There would be no parts requiring high-class construction and adjustments to be made or maintained. This explains the striving for extreme simplicity, such as is embodied in this engine, the maintenance and attendance being always considered. The development of the automatic engine has caused the type of engine here mentioned to be sadly neglected, and while it may pain many of the "sharp cut-off" advocates to see this type of engine again advocated, their attention is respectfully called to the remarkable performance, from an economical point of view, of the Willans engine, using a throttling governor.

No one would advocate a simple engine in competition with the automatic in steam economy, but experience shows that many things are possible and permissible in compounding that are not allowable in high-class automatic engine construction, and for many places there is little reason to doubt that the engine (or the type) produced by Mr. Cooper for his Centennial exhibit would be very desirable if given the proper attention in design and construction.

It is to be regretted that no data are available as to its performance which would be interesting in comparison with throttling simple engines, but these figures are lacking, for the engine ran idle and received whatever steam happened to be in the mains, and, as Mr. Cooper writes me, "this, you know, is an uncertain force at fairs."

"Design and construction may embody promise of economy and good performance, which may be foreseen without test, and especially in cases where well-known simple devices and methods of working are employed, as in this case."

Fig. 2 shows the governor. A A are the governor balls, B the valve rod, and D the valves, the latter having two sets of disks a a and b b. E is an eccentric secured to the rod d which has a weighted arm F and weight F'. When the engine is stopped the balls A A are down, the disks a of the valve in contact with the seat and the arm F down.

To start the engine the arm F is raised as shown so that the eccentric E depresses a lip f on the valve rod B, and opens the valve as shown. When the engine is fairly started the governor balls control the stem B and depress the rod still further, so that the arm f is removed from contact with the eccentric E, whose weighted arm falls and restores it to its original position. In case the belt breaks the balls fall and the disks a shut off steam, while, in case of undue speed the valve is depressed so that the disks b check the passage of steam in usual way and reduce the speed of the engine to the normal rate. Points to be observed are: Valve with shutting-off disks a a and regulating disks b b, and eccentric, weighted arm and lip f for starting.

New and Simple Formulas for Saturated Steam.

BY G. B. MAYNADIER.

Experiments show that the specific volumes of saturated vapors cannot be determined, with sufficient accuracy, by the formula for gases when the absolute temperature is taken as, very nearly, $t\,F + 360$.

A formula based on the dynamic theory of heat gives results that agree much better with the experimental values. This formula depends, however, upon quantities the exact values of which are questionable. The latent heat and the difference of pressure for one degree difference of temperature are supposed to be given, in exact figures, by the results of Regnault's experiments. The mechanical equivalent and the absolute temperature are given, respectively, as follows:

Rankine, 772 and $t + 461.2$; Zeuner, 772 and $t + 459.4$; De Volson Wood, 778 and $t + 460.66$; t being the temperature Fahrenheit. From this it is obvious that each one determines his own values, so that at 212 degrees, Rankine makes the volume of a pound of steam to be 26.36 cubic feet: Zeuner makes it 26.44 cubic feet, and De Volson Wood finds 26.58 cubic feet. The mean of these is 26.46 cubic feet; which will herein be considered as the volume of a pound of saturated steam at 212 degrees.

The product of the pressure per square foot by the volume in cubic feet will then be as follows:

$$P\,V = 2{,}116.2 \times 26.46 = 56{,}000, \text{ very nearly.}$$

From a study of the steam tables I became convinced that if the specific volumes were accurately determined, it would be found that *the product of the pressure by the specific volume increases at a uniform rate as the temperature rises.* This I believe to be a law of saturated vapors, because the results derived from formulas based thereon agree remarkably well with the results derived from the more complicated formulas now used.

For saturated steam the formulas by which this law is expressed are as follows:

$$P\,V = 56{,}000 + 56\ (t - 212)$$
$$P\,V = 45{,}920 + 56\ (t - 32)$$
$$P\,V = 56\ (t + 788).$$

The last equation has the same form as the equation for gases, and we have, for saturated steam, the following equation:

$$\frac{P\,V}{t + 788} = 56, \text{ constant, just as we have,}$$

for gases, the equation: $\dfrac{P\,V}{t + 460} = R$, a constant which is inversely proportional to the densities or specific gravities of the different gases.

It may be worth while to call attention to the probability that $\dfrac{P\,V}{t + 788} =$ constant, holds good for all saturated vapors. For some other saturated vapors the constants are, probably, somewhat as follows: Ether,

12.9; alcohol, 21.6; acetone, 16.8; chloroform, 8.3; chloride of carbon, 6; bisulphide of carbon, 12. From the equation for saturated steam, we have, $\frac{P\ V}{56{,}000} = \frac{t + 788}{1{,}000}$.

Now, $\frac{t+788}{1{,}000} = 0.82 + 0.001\ (t - 32) = 1 + 0\ 001\ (t - 212)$, $F = 0\ 82 + 0.0018\ t$, C. Then if P be the pressure in kilograms per square meter, V the volume of one kilogram in cubic meters and t the temperature Centigrade, we have for French units, $P\ V = 17{,}055\ (0.82 + 0.0018\ t)$.

For p in atmospheres and V the volume of one pound in cubic feet, t, Fahr., we have, $p\ V = 0.02646\ (t + 788)$. This equation gives results practically the same as those derived from Zeuner's celebrated formula, $p\ v = 0.043862\ (t + 459\ 4) - 3.00859\ \sqrt[4]{p}$, which is the simplest and most exact formula heretofore proposed. The greater simplicity of the new formula is apparent.

England is to have a wheel which will out Ferris Ferris, so to speak. The contracts have been let, and construction begun on a wheel which is to be erected at Earl's Court Exhibition. The wheel will be 300 feet diameter, 50 feet more than the Ferris. In general design it will be similar, and will have cars suspended from the rim in the same manner, and affording accommodation for 1,600 people. The towers are of different design, and will be fitted up with stages at various heights, to be used for amusements, cafés, etc. The passage from one tower to the other will be through the hollow axle of the wheel, which will be 7 feet diameter, of steel.

MANUFACTURES.

The Cordele (Ga.) Machine Shops, Foundry and Planing Mill will be rebuilt.

The Faatz Brush and Felting Company will erect a factory at Lestershire, N. Y.

Ground has been broken for the new Erie Chemical Works at Erie, Pa. Bleach will form one of the products.

The George Place Machine Company has removed from 120 Broadway to 145 Broadway and 86-88 Liberty street, New York.

The Safety Vapor Engine Company, which has been located at 16 Murray street, New York, moved on the 1st of May to 83 Reade street, corner of Church.

The New York office of the Bridgeport Machine Tool Works, which is managed by Mr. N. B. Lyons, has been removed to 86 Liberty street, New York.

J. A. Fay & Co., of Cincinnati, O., report an especial demand for the large sizes of the sand papering and polishing machine recently illustrated in our columns, five of these having been sold in a single week.

We have received from the J. D. Smith Foundry Supply Co., Cincinnati, O., a special supplementary catalogue No. 16, which is of interest, especially to foundrymen, as it contains illustrations of special tools for molders' use. It is sent upon application.

The Berlin Iron Bridge Co., of East Berlin, Conn., are putting up a new transfer station for the Washington & Georgetown Railroad Co., at Washington, D. C. The same company are putting up an iron and steel building, seven stories high, for James Pettit, of New York City.

W. L. Blake & Co., Portland, Me., manufacturers of fine engine, valve and cylinder oils, and manufacturers' agents for railroad, steamship and mill supplies, have taken the agency of the State for the Worthington pumps. Messrs. Blake & Co. will make a specialty of these and keep competent engineers to estimate on terms for underwriters and waterworks.

The Batopilas Mining Co., of Chihuahua, Mexico, have placed an order for four iron buildings and four bridges with the Berlin Iron Bridge Co., of East Berlin, Conn. The buildings are to be shipped by steamer to Galveston, Texas, from there by rail to the interior of Mexico, where they must be carted a distance of 100 miles on muleback up into the mountains.

The Berlin Iron Bridge Company paid on April 14th their regular quarterly dividend of 1½ per cent. Considering the hard times in all branches of business, especially among manufacturers of structural iron, we think this shows pretty good management, not to put it any stronger, and is a refreshing change in reports coming from so many quarters, of closed factories and "passed" dividends.

An Associated Press dispatch of the 25th ult., from East Liverpool, O., says: A company of striking potters and business men with a capital stock of $60,000, organized here last night to purchase the East Liverpool pottery, a four-kiln plant which has been shut down since the strike. The company has an option on the factory for $36,000 and the deal will be closed in a day or two. The plant will be started within a week and will employ a hundred men.

We have received an illustrated pamphlet describing an improved apparatus for cutting holes in iron shutters in case of fire. The apparatus consists of an upright standard carrying at its extremity a small water motor, made by the Backus Water Motor Company, of Newark, N. J. This drives, through the medium of a Stow flexible shaft, a cutter which cuts out and removes a circular section of the shutter. The apparatus is the invention of Mr. John G. Von Hofe, of New York, and is, of course, of special interest to those who have fires to contend with.

A Hartford (Conn.) dispatch of April 23d says: The works of the Schuyler Electric Company at Middletown will be shut down on May 1st, awaiting the result of a reorganization of the company. The company has been closely associated with the General Electric Company, and has done much work for it. This business has been withdrawn, the works of the General Electric Company being utilized for its own work. The plan is to reorganize the Schuyler Company independently of the General Electric. The Schuyler Company is in good financial condition, and will resume business when the reorganization is completed.

We are informed that The Brownell & Company, of Dayton, O., have acquired from the Sioux City Engine Works, the entire stock of drawings, patterns, finished and unfinished engines of the Giddings automatic type, and that these engines will, from this time, be made by the first named company. Mr. C. M. Giddings, who for the past six years has been in charge of the Sioux City Engine Works, has connected himself with The Brownell & Company, and will have charge of engineering work with them. Special tools and machinery have been recently added to the Dayton plant which adapt it to the manufacture of complete steam plants upon any desired scale.

The West Virginia University is building a mechanical laboratory adjacent to its mechanical shops, in which the light, heat and power plant of the University will be installed. Having this plant all under the same roof in the Department of Mechanical Engineering, greatly increases the facilities for instruction, as the whole plant will be available at any time for experimental work and special testing and investigation. The equipment will contain storage battery plant, arc and incandescent dynamos and motors, electrical testing and measuring instruments, simple and compound engines, installed so as to work as a triple expansion engine of 100 horse-power; exhaust steam and independent jet and surface condensers, compound pumping engines for reservoir service and duty tests, high-pressure sectional boilers, set for coal and natural gas firing; and the present equipment of standard engineering, testing and measuring instruments and accessories will be materially increased. The University is located at Morgantown, W. Va., on the Monongahela River, and on the new link of the Baltimore & Ohio R. R. connecting its Pittsburgh and Wheeling lines.

The Tradesman, of Chattanooga, Tenn., in its weekly review of the industrial situation in the South for the week ending April 30th, says: The lumber producers, who have had an unprofitable winter, are now encouraged by the prospect of a reduction in freight rates. It is believed that, with a concert of action in the maintenance of

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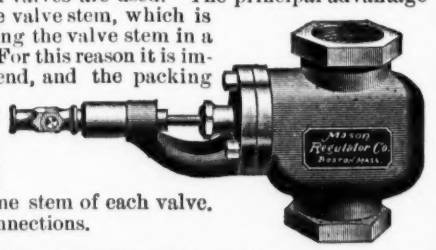

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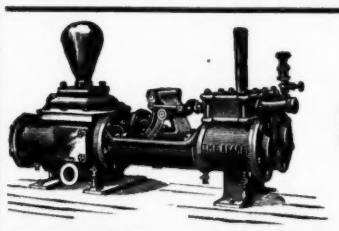

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SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
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We are building them in various sizes from 10 inch to 24 inch swing, in various lengths, both engine and speed lathes. Our designs are the latest and most approved, while the workmanship, material and finish are of the highest order. Our catalogue will tell you all about them, as well as of our planers, shapers, drills and other tools and supplies. A postal will bring it. Write us for prices.
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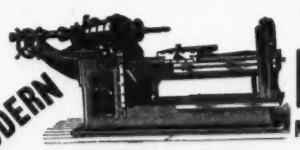

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H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.
87 MAIDEN LANE, N. Y.
JERSEY CITY. CHICAGO. PHILADELPHIA. BOSTON. LONDON

prices, and reasonable rates of freight, a large lumber business will be transacted this summer. Iron and coal operators are not as yet materially affected by the coal miners' strike. Fuel supplies, both at the furnaces and at the mines, are sufficient for present needs. It is not now believed that the strike will be so long continued or so general as to cause shut-downs for want of coal and coke. *The Tradesman* reports 46 new industries as established or incorporated during the week, among which are: The Harris Automatic Car Coupler Co., of Spartanburg, S. C., capital $1,000,000; the Jefferson County Land and Irrigation Co., of Beaumont, Texas., capital $250,000; the Kanawha Improvement and Manufacturing Co, and the Big Mountain Coal Mining Co., of Charleston, W. Va., capital of each $200,000. The International Compress Co., capital $100,000, has been chartered at Brownsville, Texas; fertilizer works costing $50,000 are to be built at Valdosta, Ga; a boat-building company, with $50 000 capital, is chartered at Little Rock, Ark.; the Richmond (Va.) Woodenware Co., capital $50,000, is reported; iron works to cost $50,000 at Buntington, W. Va., and wagon works, with $30,000 capital, at Monroe, La.

Machinists' Supplies and Iron.

NEW YORK, May 5, 1894.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $12.50 to $13.25; No. 2, $11.50 to $12.25; Gray Forge, $10.75 to $11.00. Southern brands are quoted at $11 50 to $12.25 for No. 1 Foundry; $10.50 to $11.00 for No. 2, and $10.00 to $10.25 for No. 3.

Antimony—The market is dull and quiet. We quote L. X., 9¼c. to 9⅝c.; Cookson's, 10c. to 10¼c.; Hallett's, 8.62½c. to 8.70c., and U. S. French Star, 10c.

Lard Oil—Prime is quoted at 61c. to 63c.

Copper—The market is dull and weak, the demand is light. Lake Copper is not active, the quotations are easy at 9.45c. to 9.50c. Casting Copper is held at 9.10c. to 9.15c.

Lead—The market is quiet. Lead cannot be bought at less than 3.40c. for New York delivery. The official bullion quotation remains at 3.20c.

Spelter—The market is weak and unsettled, the prices are nominal at 3.55c. to 3.60c. for New York delivery.

Tin—The market is unsettled, legitimate buyers for consumption leave the market alone. The local price for prompt delivery is firm at 20c.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

A mechanical draftsman desires engagement. Address Staff, AMERICAN MACHINIST.

A prac. mech., 8 yrs. foreman, wants pos.; age 34, habits A 1. Foreman, AMERICAN MACHINIST.

Draftsman, designer, with practical shop exp., age 25, desires pos. H. O., AMERICAN MACHINIST.

First-class patternmaker desires situation. Refs. and habits A1. M., AMERICAN MACHINIST.

Toolmaker, machinist, 34, experienced on hardening fine tools, care of tool-room and shop mach'y, wants position. Box 68, AMERICAN MACHINIST.

A mech. engineer, thorough machinist, good designer and draftsman, desires situation with growing concern; will invest $500. Advance, AM. MACH.

Wanted—Position in boiler or sheet-iron shop to lay out and work sheet-iron; best refs. Charles Osborn, Gen'l Delivery, Brooklyn, N. Y.

Young man, 22, wants place in drafting-room; has 15 months office, 9 months shop exp. Engine work pref'd. "T. D. P.," AMERICAN MACHINIST.

Wanted—Position by a machinist and toolmaker who is capable of taking charge of works. Address "Energy," AMERICAN MACHINIST.

Wanted—Place as superintendent or foreman by first-class toolmaker and machinist used to close interchangeable work; can work men to advantage. Address Box 74, AMERICAN MACHINIST.

Young man desires position in shop or drawing office; 6 yrs' exp. eng. fitting and erecting at loco. shops Great Eastern Ry, London, Eng.; also holds certificates in mach. draw'g, etc. E. N., AM. MACH.

Wanted—By a good, steady, temperate molder, a situation either as a molder or to run a small country jobbing foundry, with from 1 to 6 men. Address Small Foundry, AMERICAN MACHINIST.

(*Continued on page* 14.)

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7	1½	.95	16	5	3.25
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1 Set to 2 in.		7.80	Full Set.		$31.10

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Office and Works,
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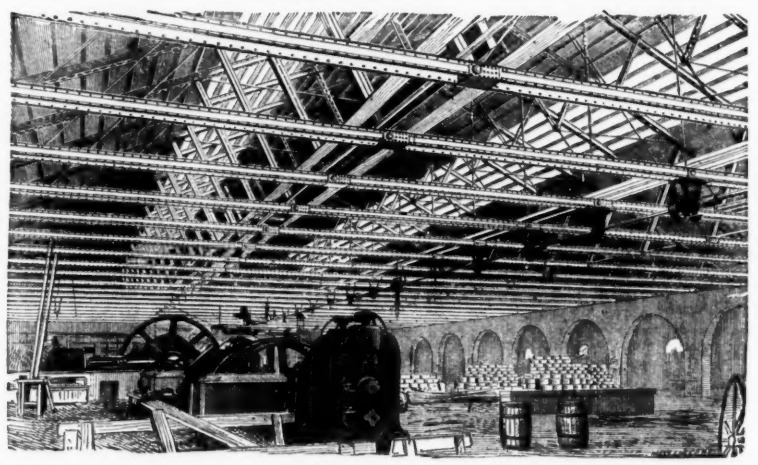
Engineers, Architects and Builders of Iron and Steel Bridges and Buildings.



The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Coe Brass Co., at Torrington, Conn. The Roof is over their Rolling Mill, which is a building 118 feet wide and 233 feet long. The line of brick arches, shown on the right, connects with an adjoining Muffle Room which is also covered with an Iron Truss Roof designed and built by us.

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COMBINING EVERY IMPROVEMENT.
14 SIZES FROM 5 TO 20 FEET.
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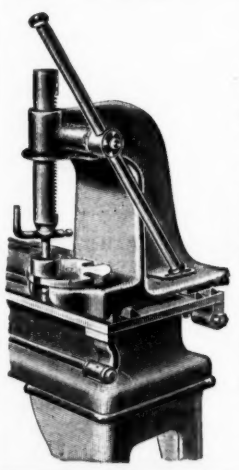

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Do you make Shrink or Force Fits?
We have an Inside Micrometer Caliper that is just the tool for this purpose. Its price is only $1.75. We have another (price $6.00) that will actually measure a hole or length in inches and fractions thereof from 2½" to 15" by thousandths.
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ALL KINDS IN STOCK.
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Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
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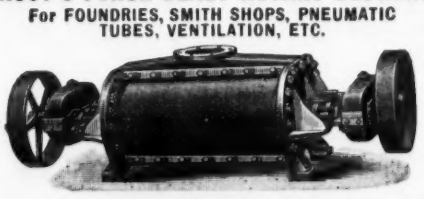

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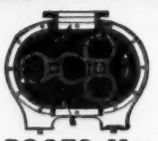

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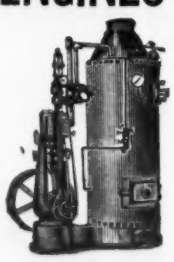
ENGINES and BOILERS.



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Plain and Automatic.
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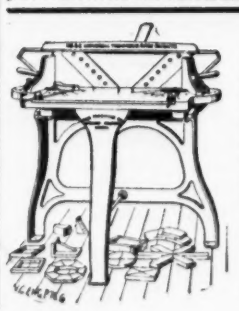

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PUMPING ENGINE
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SIMPLE, COMPOUND, OR TRIPLE EXPANSION,
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HIGHEST DUTY GUARANTEED.
COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
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NEW YORK,
BOSTON, PHILADELPHIA, CHICAGO, ST. LOUIS, DENVER.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Draftsman and vise hand, graduate of a technical school in Germany, have some experience in designing; wishes position in drawing-room or shop. Address H. F., 15, AMERICAN MACHINIST.

Patternmaker, 34, desires position as foreman, have had charge of men, can manage shop in a practical and economical manner; best of refs. Address E. F., AMERICAN MACHINIST.

A first-class man having 12 years' experience in the manufacture of steam engines on a large scale on the interchangeable plan and jig system, desires a position as superintendent. Address C. D., AMERICAN MACHINIST.

Young man experienced in foundry management, technical education, machinist by trade, wishes pos. as machinist in shop where there is a good chance to work up, and if satisfactory invest some money. R. A., AMERICAN MACHINIST.

Able mech. engineer wants responsible position; general machinery with power transmission as specialty, also water wheel and structural work. Best theoretical and practical training; first-class designer; can show up work. K., AM. MACH.

Wanted—By first-class machinist, position as foreman or any capacity where ability and faithful services will be appreciated. Exp'd in marine and stationary engs., and rolling-mill mach'y; good draftsman, vicinity of N. Y. Box 76, AM. MACH.

Engagement Wanted—Mech. engineer, exp'd in design, construction and operation of mining machinery, also machine tools and automatic machines; C. E. graduate; Jun. A. S. M. E., and other societies; good refs. BOX 75, AM. MACHINIST.

Wanted Situation as superintendent or foreman by expert and all-round machinist having large and exceptional exp. in the manufacture of mach'y for making lead pipes, lead incased, lead composition and block tin pipes; covering electric and other cables with lead; sheet lead rolling mills; tea lead rolls and machinery for the manufacture of lead shot, by the most improved methods known to the trade. Has supervised the erection and working of lead plant in Argentina and Brazil, also in England, Scotland and the continent of Europe. Or would take the management of lead works. Address W. J., AMERICAN MACHINIST.

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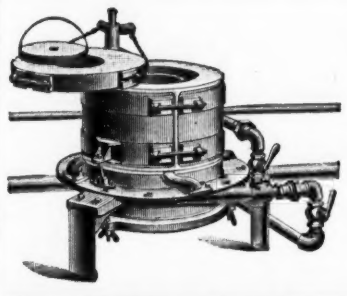

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Modern Style, in Good Order, Being the Equipment of a
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WILL BE SOLD LOW BEFORE REMOVAL.

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60 " x 24 " Heavy Pattern.

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Radial Drill, 86 in., complete.

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12 in. x 6 ft. Reed.
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16 " x 6 " New Haven.
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18 " x 8 " Putnam.
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22 " x 12 " "
24 " x 12 " Putnam.
32 " x 16 " Gleason.
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We offer at very attractive prices, a lot of machinery from
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Also a large stock of
SECOND-HAND MACHINE TOOLS
of all kind, in excellent condition. Write for complete list, descriptions and prices.
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The following machinery, used but a short time, guaranteed first-class condition. Prices and further particulars upon application:
1 No. 2½ Pratt & Whitney Screw Machine with wire feed, revolving head.
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1 Beaman & Smith Horizontal Boring Mill, table 6 ft. x 10 ft., with 5 in. bar.
2 50 in. Gould & Eberhardt Entirely Automatic Gear Cutters, will cut worm, spur and bevel gears.
1 4 in. Hurlburt & Rogers Cutting-off Machine.
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1 Adt Wire Straightening Machine.
2 15 in. Bardons & Oliver Monitor Lathes with draw back collett.
1 No. 3 Garvin 4 Spindle Drill Press.
1 Garvin Screw Slotting Machine.
1 Pedrick & Ayer 8 in. Wing Patent Wet Grinder.
5 American Tool and Machine Co.'s Speed Lathes, 14 in. swing, with dovetail set over and 2 motions to spindle.
9 10 in. Speed Lathes with quick return to spindle for drilling
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Adjustable Blade Reamers,
½ in. to 2½ in.
Send for New Pamphlet.
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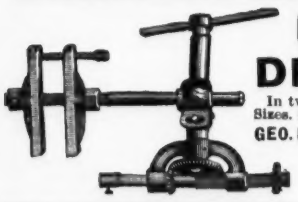
"Two Medals Awarded at Chicago Exhibition."
PROVIDENCE, R. I., U. S. A.



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In two Styles and four Sizes. Send for circular to
GEO. BURNHAM & CO.,
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FOR SALE—GEAR CUTTERS.
One 48" Gleason Planer. One 42" Gleason Planer. One 72" Niles Rotary, Automatic Feed. One 36" Blaisdell, Hand Feed. All in perfect condition, good as new. Write for full descriptions and prices.
P. H. & F. M. ROOTS CO.,
CONNERSVILLE, IND.

"The Mills of the Gods Grind Slowly,"
BUT NOT SO OF
OUR **Lathe Centre Grinder**
Just the Tool for You.
TRUMP BROS. MACH. CO., Mfrs.,
WILMINGTON, DEL.

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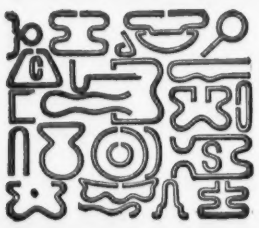

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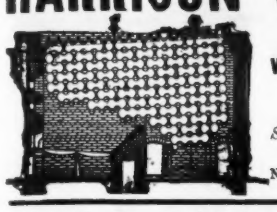

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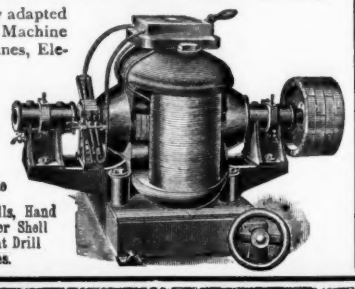

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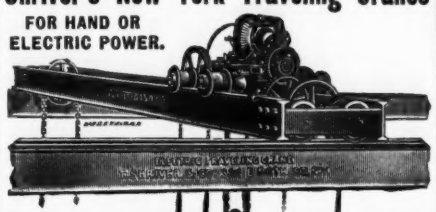

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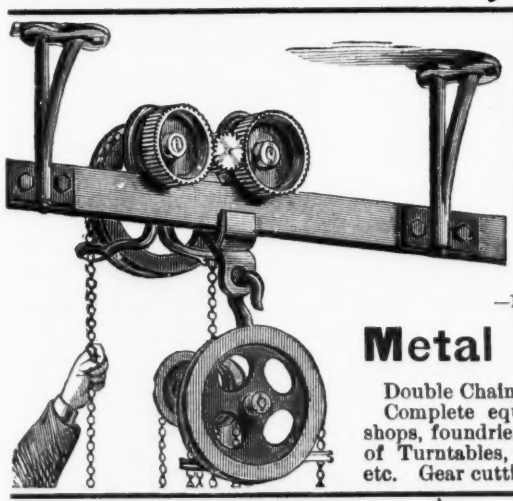

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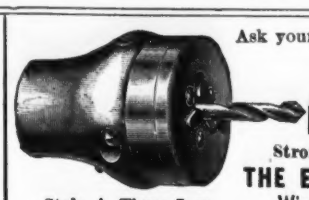

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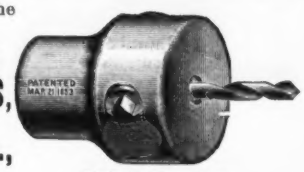

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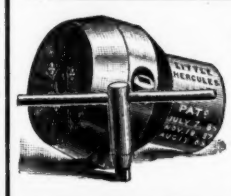

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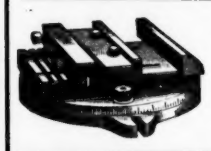

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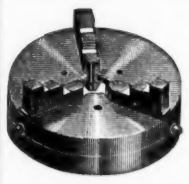

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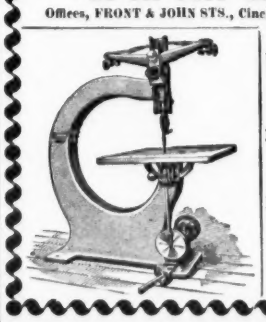

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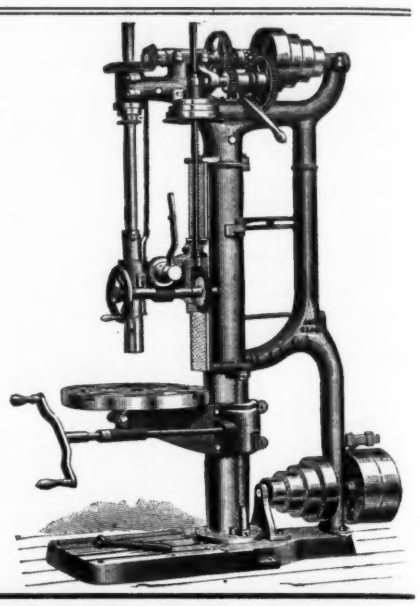

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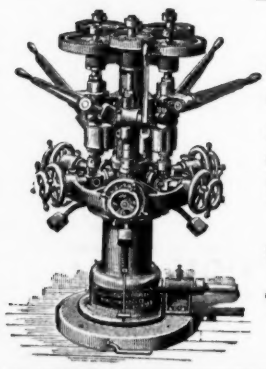

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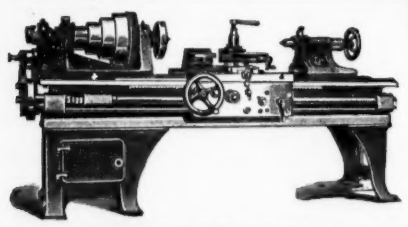

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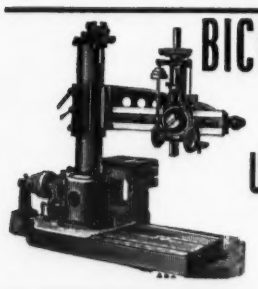

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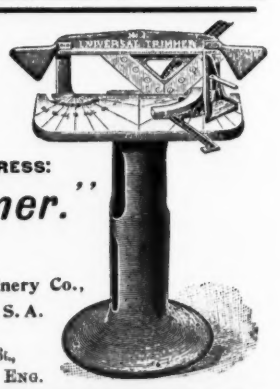

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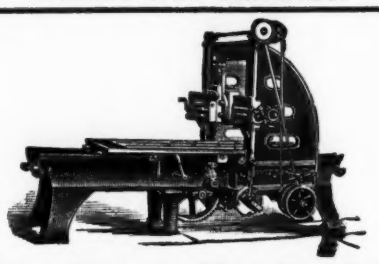

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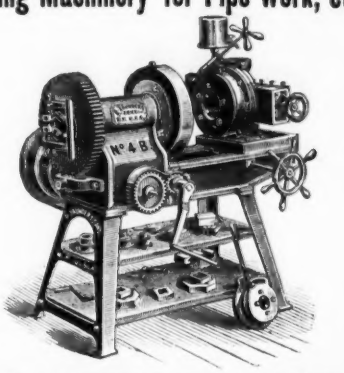

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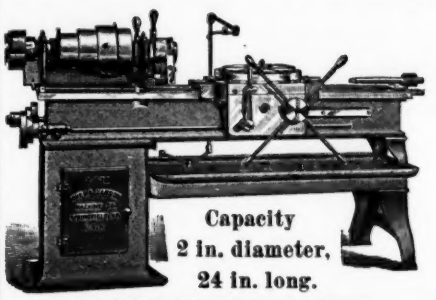

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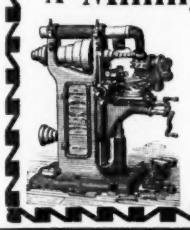

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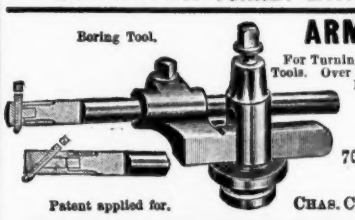

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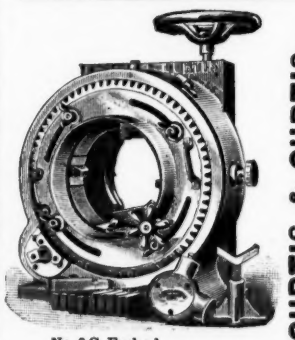

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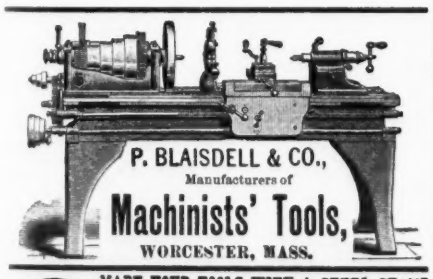

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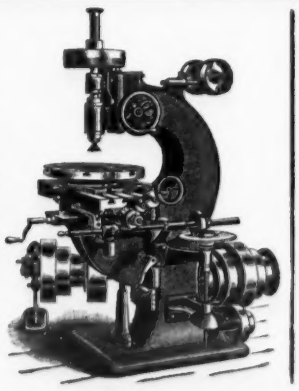

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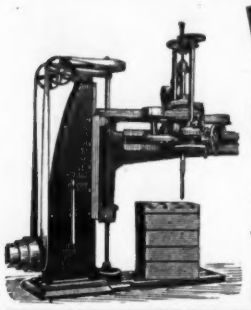

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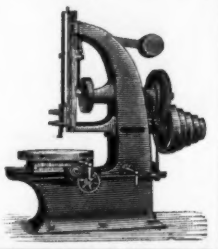

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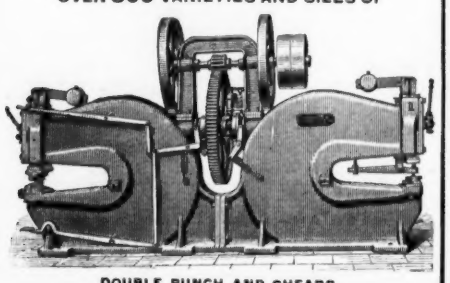

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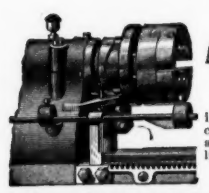

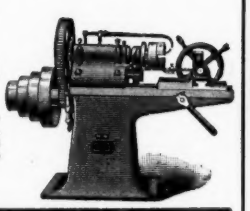

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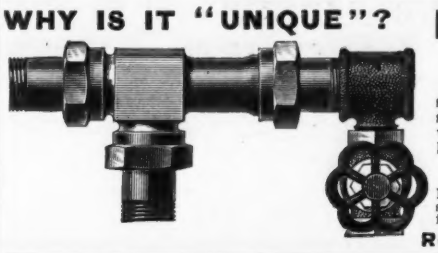

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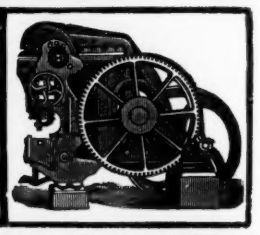

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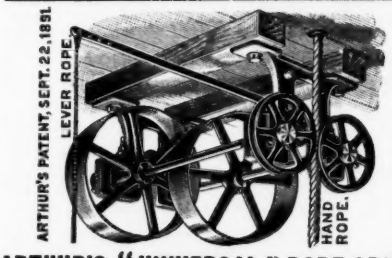

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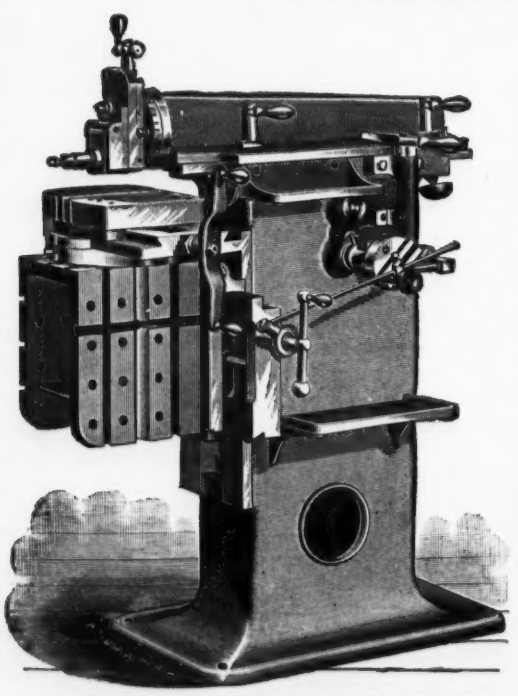

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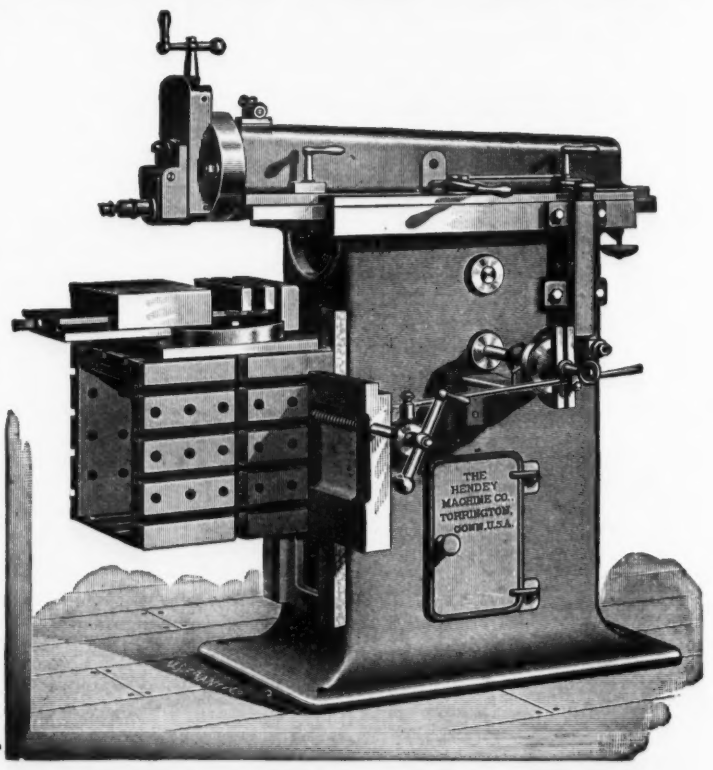

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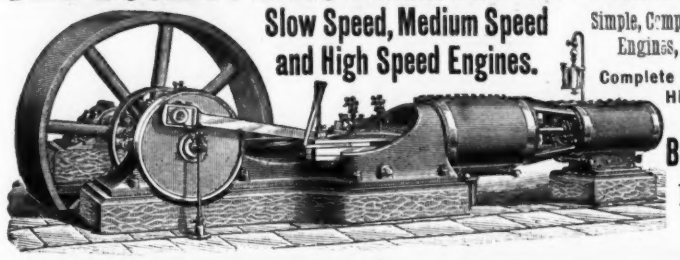

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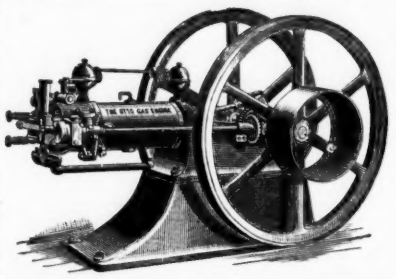

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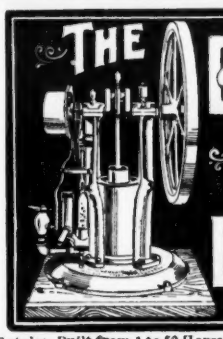

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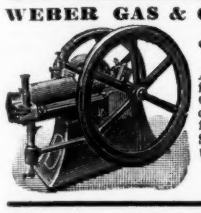

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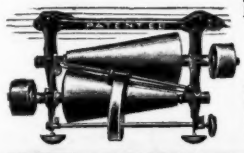

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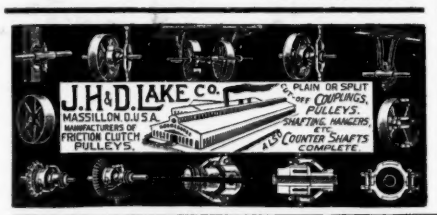

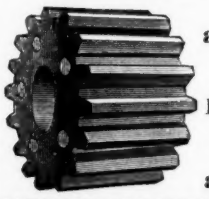

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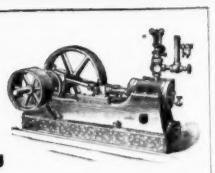

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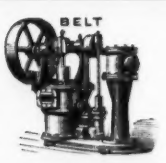

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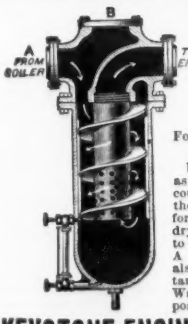

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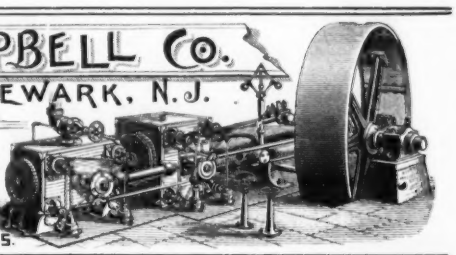

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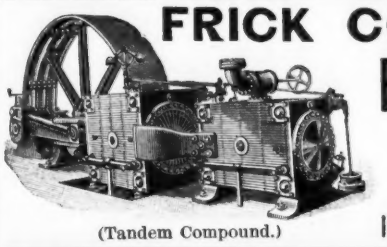

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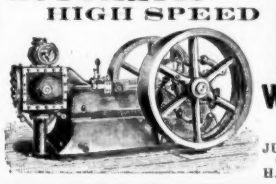

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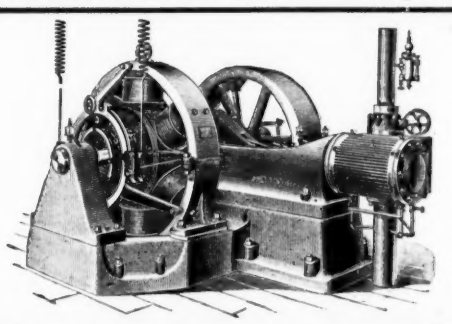

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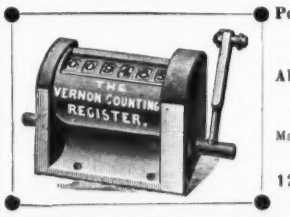

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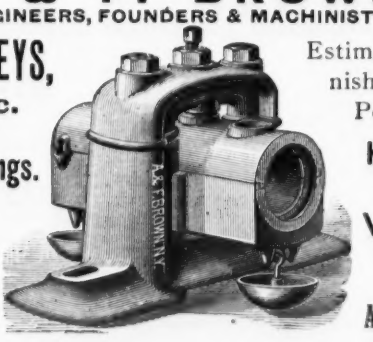

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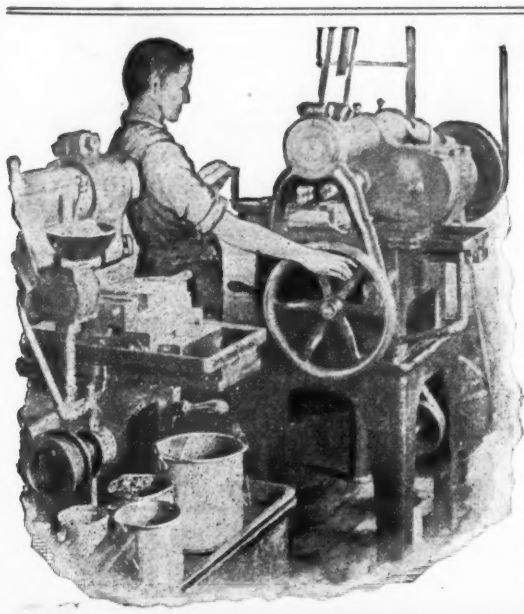

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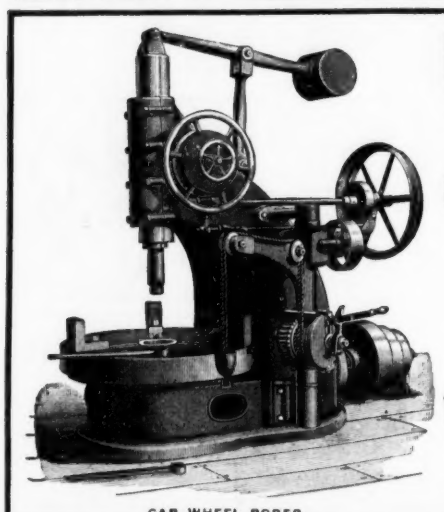

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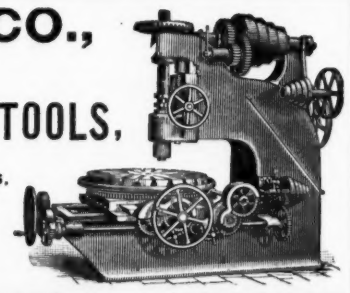

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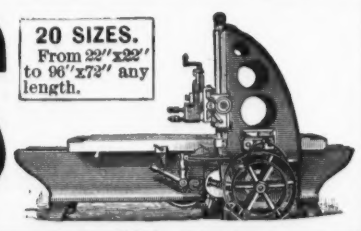

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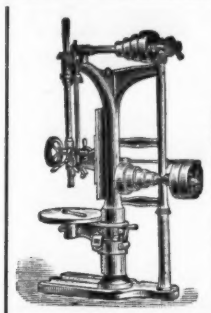

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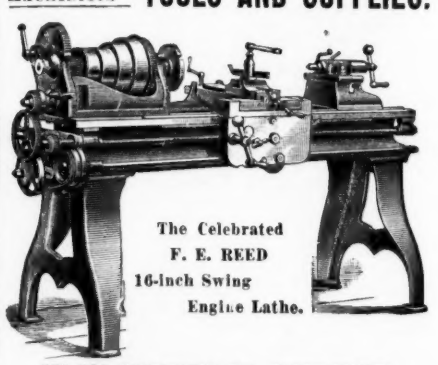

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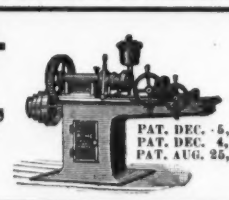

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